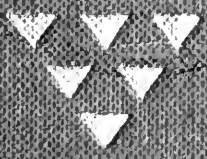
THE ECONOMICS OF MANUAL TRAINING



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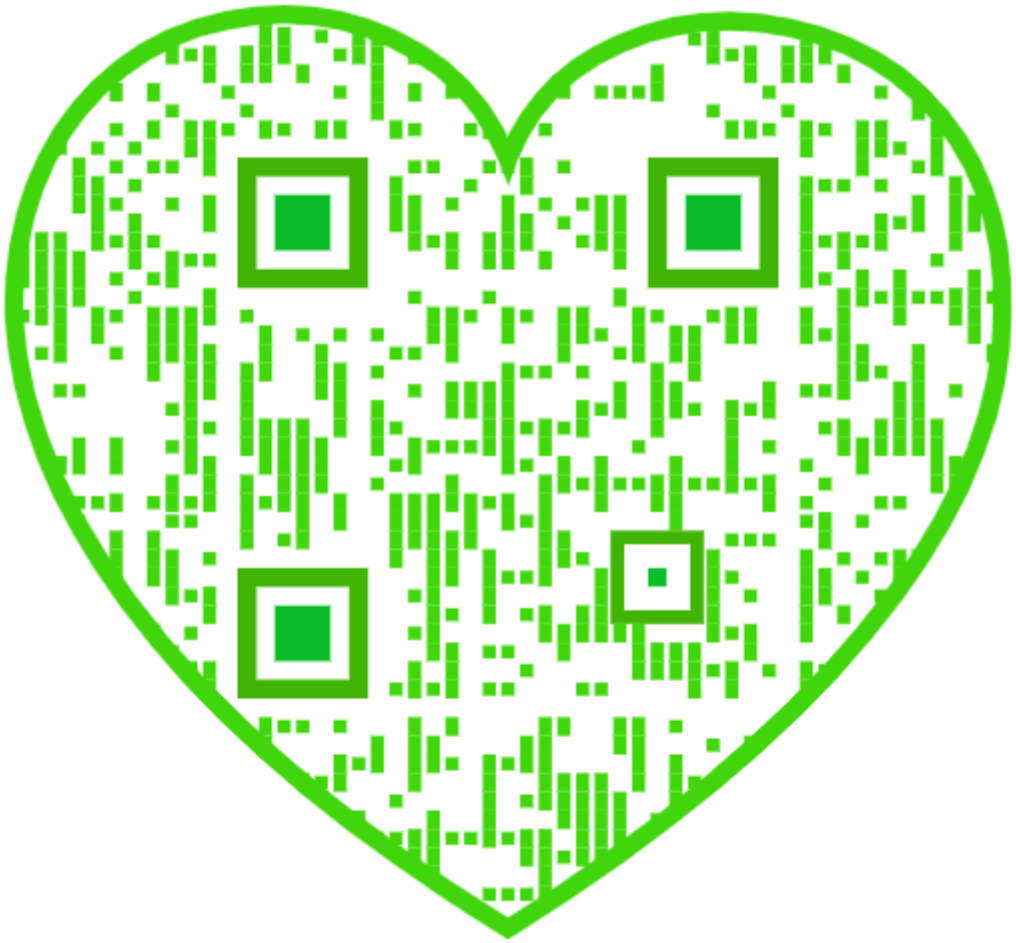

Class I

Book .5

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The Economics of Manual Training

A Complete Treatise Giving Just the Information Needed by All Interested in Manual Training, Covering the Cost of Equipping and Maintaining Hand Work in the Elementary and Secondary Schools

By

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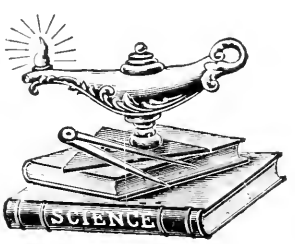

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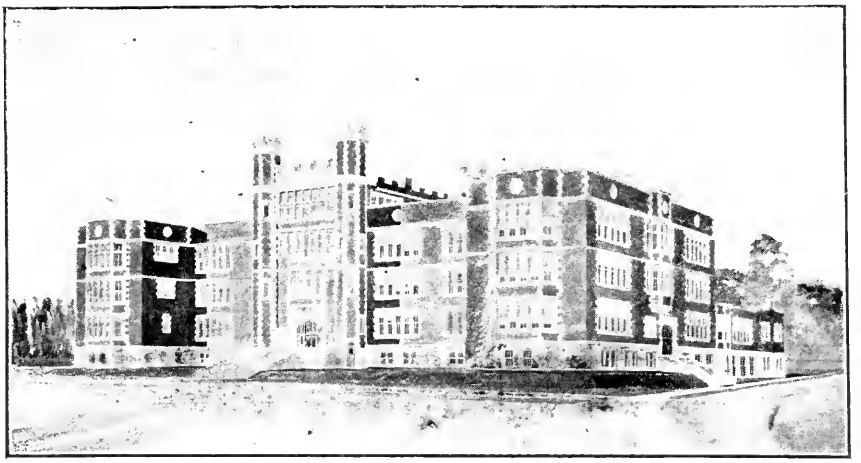


The William McKinley High School, St. Louis, Mo.

The Economics of Manual Training.

▼ ▼ ▼

The impetus given to the introduction of hand work —popularly termed manual training—in the schools of the United States during recent years has been little short of phenomenal. No school system making any pretension to completeness can now consistently ignore the claims of manual training to being an integral part of the curriculum. So widespread has the recognition of these claims become that many of the largest school systems in the country have not only introduced hand work as a part of the regular class instruction in all the elementary grades, but extensive and specially equipped buildings have been erected for manual training in the secondary schools. Types of this class of school buildings—views and plans of some of which may be found in the latter part of this book—are, The William McKinley (Manual Training) High School, and The James E. Yearman (Manual Training) High School of St. Louis, Mo., the Manual Training High Schools of Indianapolis, The Manual Training

High School, Kansas City, Mo.; Mechanic Arts High School, Boston, Mass., and the Rindge Manual Training School, Cambridge, Mass. These few names might be extended into a long list if the names of similar schools in almost every large city were added. The recent opening of the new manual training high school in the borough of Brooklyn, New York City, with its accommodations for 2,500 students, and for the building and equiping of which $800,000 was expended, is surely a striking commentary upon the position which manual training has attained. And this position is emphasized in this particular case when the fact is recalled that the building in the borough of Brooklyn is but one of a series of such buildings destined to be a part of the school equipment of Greater New York.

So rapidly has the acceptance of the manual training idea spread and found concrete expression that the supply of adequately trained teachers and supervisors of manual training has been far short of the demand. There has also been a lack of available and reliable data, ready at hand, dealing with the general subject of the cost of equiping and maintaining manual training in the various school grades and in the high school. It is a recognition of this latter demand, and a purpose to attempt to supply the desired data that seemingly justifies the issue of this book.

It is proposed herein to give definite data, as far as is practicable, as to the cost of manual training in each of the grades and the four years of the high school. An endeavor will be made to make this information of a kind applicable to varying conditions of school work. It will be appreciated, however, that manual training in the grades is not a clearly defined quantity. It may almost be said to vary directly with the number of cities and towns

wherein manual training is a part of the curriculum. At present the practice of manual training is happily progressing from the state of fixed self-contained courses in different media, aiming purely at proficiency in certain processes, to the freer use of hand work as an expression of the various school interests and needs.

For such work it is evidently far more difficult to render an estimate of expense than for the older conditions, and the best that can be done is to analyze as far as possible the data of costs upon the basis of various materials and processes and leave to the reader the task of making the necessary deductions.

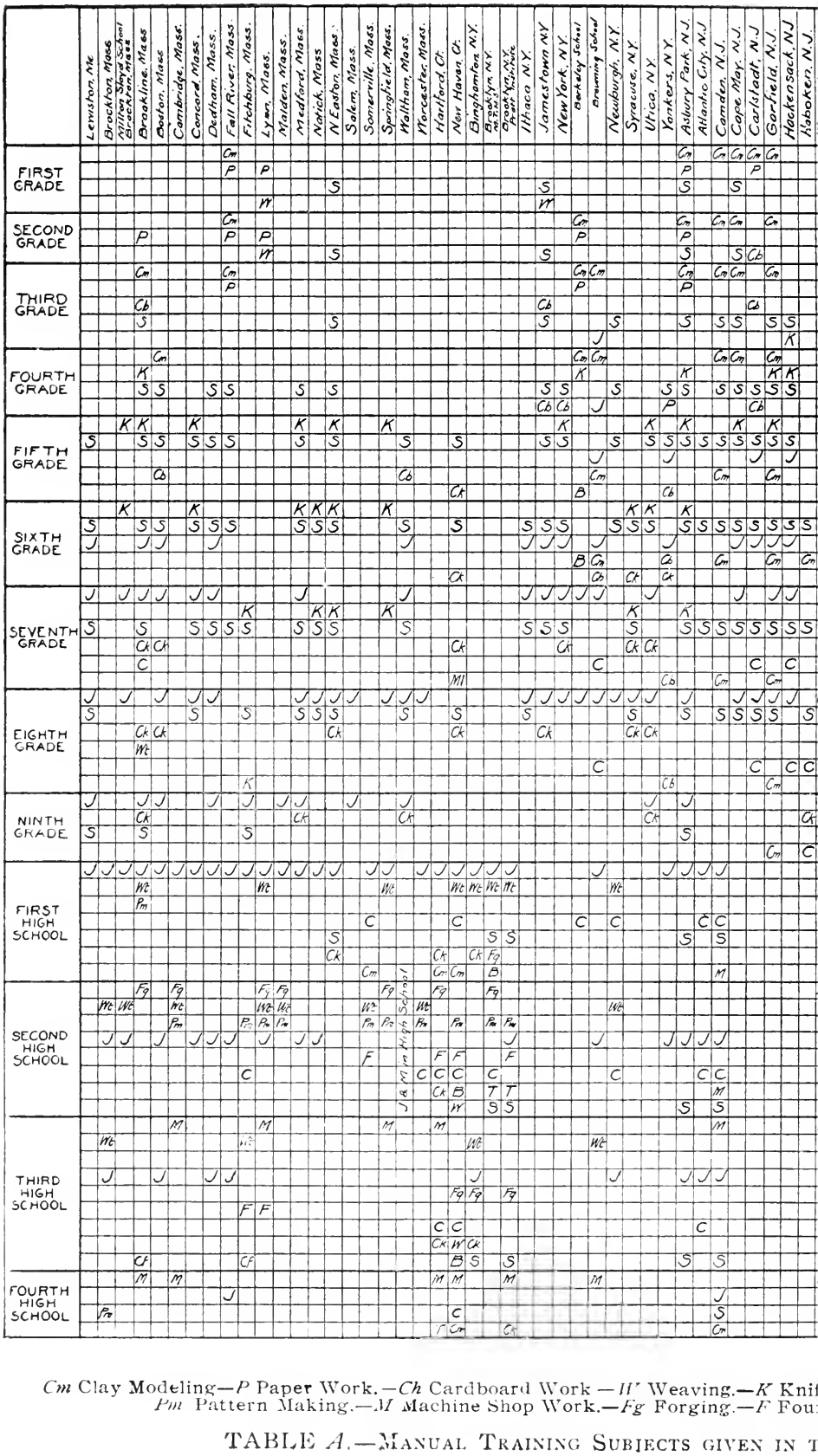
The lack of uniformity in manual training practice, at the present time, is especially true in the lowest grades. In the later stages of the elementary school, and particularly in the high school, the character of the work becomes more and more uniform, both as to processes and actual undertakings.

This is in part due to the historic development of the subject in our country. Logical development and growth would seem to demand the primary introduction of such work in the kindergarten and its gradual incorporation in successively higher grades until the high school is reached. This, however, is almost the reverse of the actual fact. Hand work did indeed make an early appearance in the kindergarten, but its arrival in the public schools was in the high school field, and from this point it has worked gradually downwards in the grades, bearing generally strong evidences of the original influences.

The character of the early work done in the high schools, which has persisted to the present time in only a slightly modified form, was very greatly influenced by the recently organized shop work courses of certain engineer-

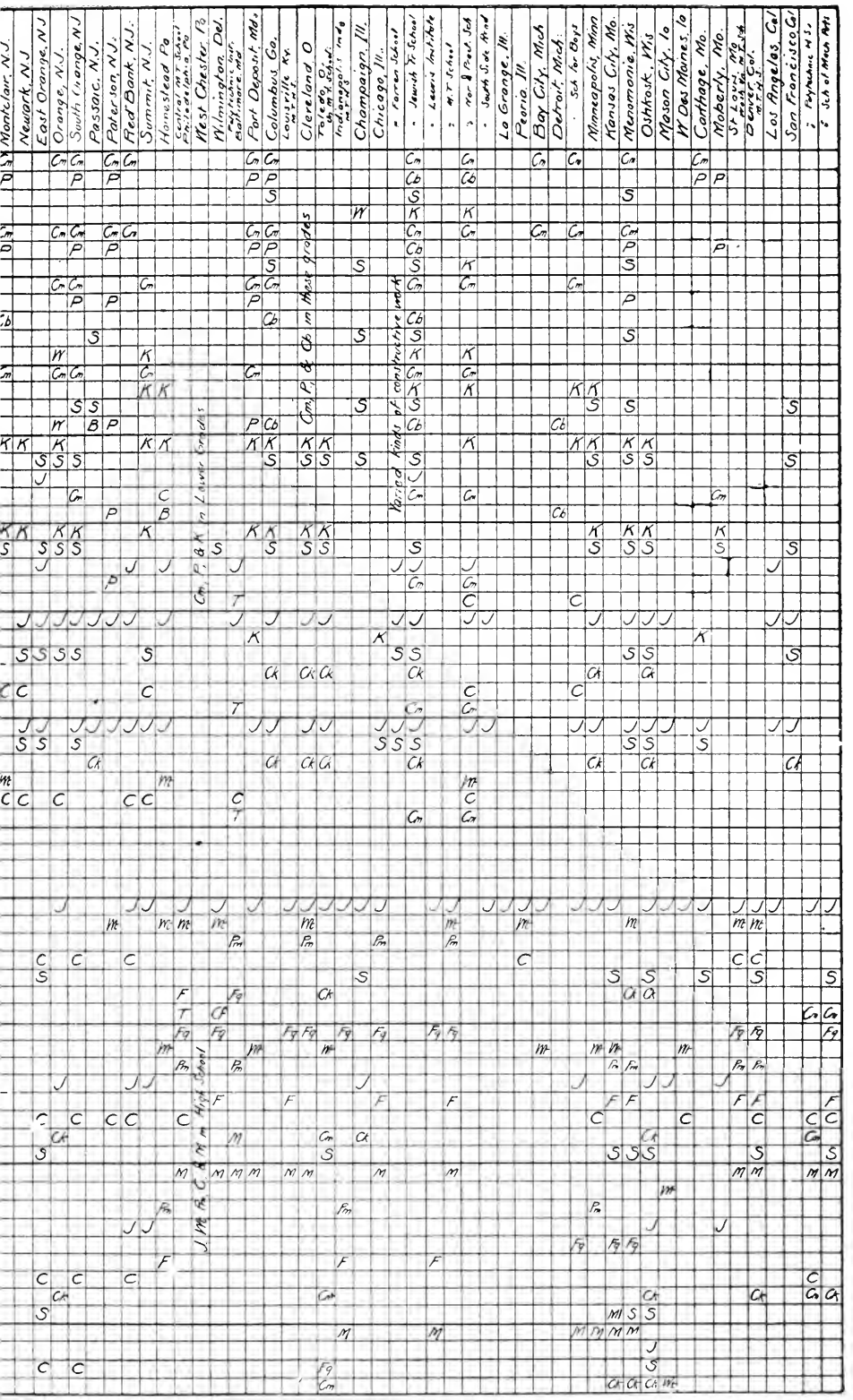
ing schools. In these courses a quite uniform school of instruction had been developed, involving joinery, turning and pattern-making in wood, followed by forging and foundry work and finally by machine work. When the first manual training high schools were organized their manual training work was patterned in general character and even in detail upon these courses, and in the rapid spread of such schools this general scheme has remained substantially unchanged.

The more recent introduction of manual training into the regular high school has, however, resulted in modifications in the general plan. This is partly traceable to the lesser proportion of the school time allotted to shop work, partly to the attitude maintained towards the subject, and sometimes to the lack of sufficient funds to completely equip a full set of shops. The plan in such schools is naturally to expand simpler elements over more time and to omit the later and more expensive branches. In the elementary school the practice of bench work in wood quite generally prevails in the eighth and seventh grades. This work is also of a quite definite character, and its acceptance as the best adapted branch of hand work for the boys of the two upper grades of the grammar school seems assured. Below the seventh grade the variations in practice begin to be marked. In some schools the inclination is to begin bench work in the sixth and even in the fifth grade. The trend of the larger number of cases appears, however, to be to introduce into the sixth and fifth grades wood work not requiring benches and a separate laboratory equipment. This kind of work is very commonly known as knife work or whittling. Work in cardboard is often found in the next lower grades; say, the fourth and third. This work is actually carried on, in



Cm Clay Modeling—*P* Paper Work.—*Ch* Cardboard Work —*W* Weaving.—*K* Knit
Pm Pattern Making.—*M* Machine Shop Work.—*Fg* Forging.—*F* Fou

TABLE *A*.—Manual Training Subjects given in T



—*S* Sewing.—*B* Bent Iron Work.—*Ck* Cooking.—*J* Joinery.—*Wt* Wood Turning.
C Carving.—*Cf* Chipping and Filing.—*Ml* Millinery.—*T* Tinsmithing.

ARIOUS SCHOOL YEARS IN THE SCHOOLS ENUMERATED.

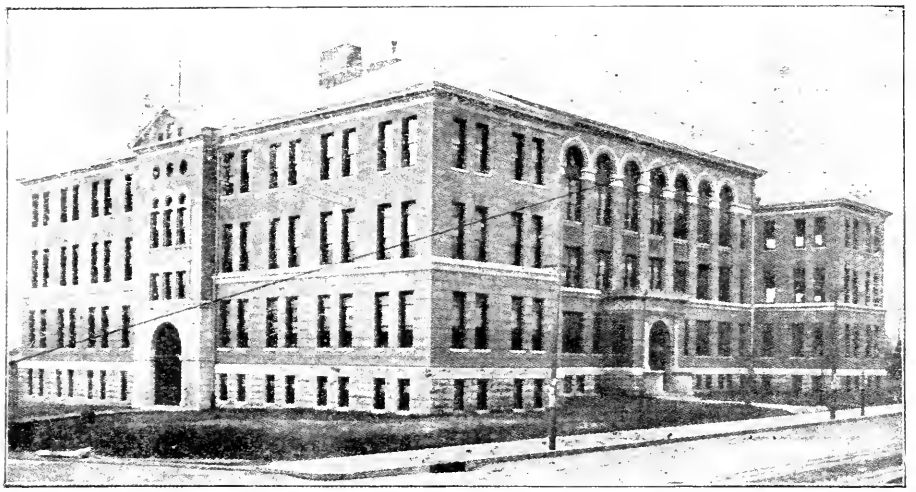
some schools, in any or all of the grades from the second to the seventh. Work in bent iron (often called Venetian iron work) is frequently used in the fifth and fourth grades. In the first three grades are found clay modeling, paper folding, weaving, and sewing, more or less correlated with the other studies of these grades.

The accompanying Table A was compiled in 1900 chiefly from data furnished by the various schools in answer to requests made to them by letter. The table shows the manual training subjects given in each of the grades and in each of the high school years, in the schools enumerated.

The division of the elementary school course differs in different parts of the country. Schools with seven, eight, and nine-year courses are represented in the table. In the high schools both three and four-year courses are represented. The table is arranged so as to show at a glance the prevailing subject taught in any one year and to afford an opportunity for comparison. In the subsequent consideration of subjects taught in the various grades the basis assumed is that of an eight-year elementary course and a four-year high school course.

In selecting the illustrations for the text an attempt has been made to show a typical course in each of the materials used in manual training work in the grades, and also types of existing class room equipments. In the consideration of the secondary school equipment a further attempt has been made to incorporate such working drawings of special equipment as may prove suggestive and helpful.

All such general items as teachers' desks, chairs, and blackboards have for convenience been omitted from the following schedules.



Manual Training High School, Kansas City, Mo
Plans shown on pp. 163, Fig. 65.

Elementary School.

▼ ▼ ▼

Manual training in the first three grades is generally carried on in the regular class room, under the instruction of the regular teacher, and at a nominal cost. The work customarily assumes some phase of modeling in clay, construction in paper, sewing, and weaving with various materials. This work is accomplished in many instances at an expenditure of but two cents per pupil. Some schools expend five times that amount and even more. Under competent and economical management the cost in these grades need be but slight. This work at the present time is greatly diversified in character and depends largely upon the ability, sympathy, and inventiveness of the teacher.

Clay Modeling.

Clay modeling is a form of manual training that may profitably be carried on in any of the classes from the

kindergarten through the high school. The abundance and cheapness of the material used, its adaptation to the muscular limitations of the child, as well as its possibilities for expression of the subtleties of form in the hands of the high school student, the rapidity of attainment of results, and certain of its physical qualities, make it a desirable and acceptable medium for manual training work.

The disadvantages connected with its use are generally negligible or surmountable. These disadvantages may be summed up in the necessity for keeping the clay constantly moist during the entire period of its manipulation, the difficulty attending its manipulation in bulk, which is generally too laborious for the class teacher and requires the service of the janitor or other assistant, and the mooted question of hygiene. On this last point Anna M. Holland* says: "Clay, being an entirely mineral substance, affords no food for the growth of bacilli; it can therefore be used many times with reasonable care. I have never had reason to believe that the least danger lurks in the use of clay, even to delicate children."

Hermione Unwin† says upon the same subject: "It has been charged against clay modeling that it is liable to spread infectious diseases in schools. No authentic case of such an occurrence has been found, and infection is far less likely to arise from clay than from books or from contact of clothes. It must be insisted on that the children come to the lesson with clean hands, and a child having anything the matter with its hands should not be allowed to touch the clay; or, if this is permitted, the clay used should not be mixed with the rest, but thrown away. If, however, stronger measures are desired, the clay may

*Clay Modeling by Miss Anna M. Holland.
†A Manual of Clay Modeling by Hermione Unwin.

be sprinkled with Sanitas disinfectant, instead of water, and then well kneaded up, so that the Sanitas is thoroughly incorporated with every part."

Clay.

Pure Clay results from the weathering of granite, a rock containing felspar, mica, and quartz. The alkalies are leached out by the weathering and the silicate of alumin is hydrated and washed out from the less finely divided quartz.

Clays are fitted for their use in making pottery by two main properties:

The ease with which they may be moulded and shaped when wet, and

Their change of state to a hard unalterable condition when fired.

According to their relative plasticity and refractoriness clays are of three classes:

Porcelain Clay. Approximately pure kaolin, poor in plasticity, refractory, and burning to a white or light cream color.

Plastic Clay. Less pure than porcelain clay, more plastic and less refractory, burns to a yellow-red color, and used for ordinary earthenware and common bricks.

Fire Clay. Highly refractory, dark in color, and used for furnace linings and crucibles.

Plastic clay is that made use of in school work. It may be purchased, in dry form, from dealers, or, "worked-up," from potteries. If the models are to be fired in the school kiln, care must be exercised to select a clay that can be fired at the relatively low heat of the kiln. When the clay is purchased dry it must be worked up with water. This process entails considerable labor and

strength, and the good offices of the janitor should be enlisted. The dry clay, either as purchased or from old models, may be tied up in a strong cloth and soaked in water for about two hours. It should then be well kneaded before removing from the cloth. The kneading is continued until the required degree of plasticity is obtained. A teaspoonful of glycerine to five pounds of clay will render it less sticky and improve the exterior finish of the product.

Substitutes for Clay.

Various substitutes for common clay for modeling purposes are offered by the trade. They are presumably composed of wax mixed with other substances and are trade secrets. They are placed upon the market under various names as Pastilina, Composite Clay, Composite Modeling Wax. The chief advantage over clay claimed for the substitutes is that the work can be left standing for almost any length of time, without drying, cracking, or shrinking, and requires no sprinkling with water or covering with damp cloths. The substitutes are furnished in two or three different colors and of varying consistencies.

The disadvantages of the use of some of these substitutes are:

The very much greater cost as compared with clay, and

The disagreeable odor emitted.

Paper pulp has been used as a substitute.

The following quotation, from the instructions issued by the Manual Training Department of the Elementary Public Schools of Chicago, may be of interest here: "Paper pulp is a substance which any one can easily make and use in place of clay * * * for modeling. The

material costs nothing and is so clean and pleasant to work, it is surprising paper pulp has not been more generally applied in constructive work. To make pulp of papier mache, tear any waste paper (newspaper or writing paper will do) into pieces not more than one inch square. Fill a bucket with these bits of paper and pour over it about a gallon of hot water (boiling). Let the paper soak for five or six hours and then drain off the excess water. If now the mass of wet paper is worked vigorously with a stick, churning it and thus tearing the bits of paper very fine, you will have, at the end of a few minutes, an excellent quality of paper pulp. The pupils will enjoy the making as well as the using of this material."

Equipment.

Storage.

Clay should be stored in a zinc-lined box, and a wooden scoop or small shovel provided for getting the clay out of the box.

Storage for students' work in process of construction must be provided. An ordinary cupboard or closet will suffice, or simply shelving. On account of the action of moisture it is desirable that cabinets used for the storage of clay work be zinc lined. A cabinet similar to that described below for the storage of drafting-boards in the mechanical drawing room will be found convenient. The slides at the side might be made by folding the zinc and riveting.

Modeling Boards.

Slates make excellent modeling boards. The slates may be either roofing slates or the common school slate with frame. They should be of uniform size to facilitate

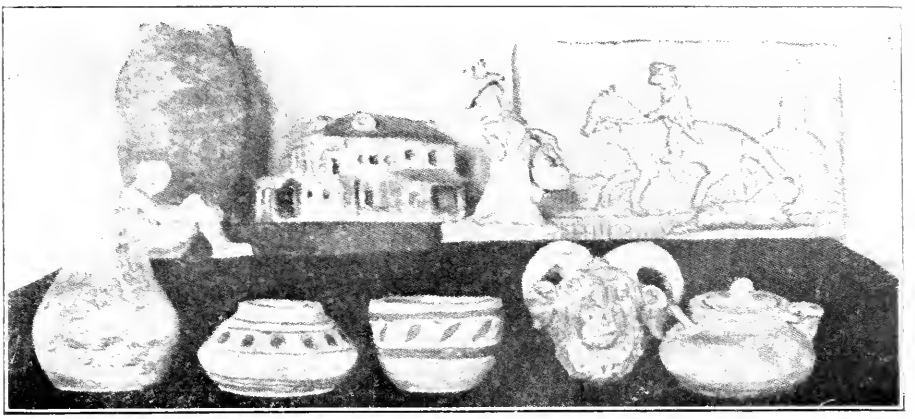


Fig. 1. Clay Modeling done by Children of 4th and 5th Grades in Montclair, N. J.

Fig. 2. Clay Modeling Room at Montclair, N. J.

storage, either in cabinets, or by any other method chosen. In lieu of the slate, a piece of oil cloth, or even a piece of manilla paper may serve for the work in the lower grades.

Work Tables.

The school room desk will serve every purpose for

grade work. Where a special room is provided a simple table is required. The pattern used in Montclair, N. J., is shown in Fig. 2. By referring to the illustration it will be noticed that the work is being done on school slates and that individual shallow tin trays are furnished for the clay. In high school work it is desirable to have specially designed modeling benches.

On the subject of equipment for clay modeling, Miss Holland says: "The room should be large enough for tables and chairs to accommodate a class of not more than twenty-five, cases for unfinished work, and tight boxes to hold the clay.

"Wall space for models (which may be of fired clay or plaster) and drawings, is also needed. The tables may be very simple, but should be thirty inches long and at least sixteen inches wide, with a strip at the back to prevent the clay from falling off. The back should have a vertical board attached (16 x 6 inches), with a snap to hold drawings. Roofing slates (9 x 14 or 16 inches) are good to work on, and partitioned cases with glass doors, and as little wood to shrink and swell as possible, are best to keep the work. The necessary tools are rules, compasses, triangles, and little wooden modelling knives, such as are sold at kindergarten supply stores. These must be shaped slightly with a knife and serrated. A rubber sprinkler is convenient, or a watering-pot, for wetting the clay. A set of models and blue prints is also needed. The cost of the entire outfit need not exceed three dollars per pupil for a class of twenty-five, and may be much less if several classes use the same room, which can be of service for other manual work, like sewing, map-making, etc."

Tools.

The only tool required is a simple modeling tool.

Even this is dispensed with in the earlier work. For supplementing the scrutiny of the eye and testing the accuracy of the work a rule and pair of calipers may be provided.

Models.

In the earlier grade work natural models may be provided, such as fruit, vegetables, shells, leaves, flowers, etc. If possible, individual models should be provided, or one model for two pupils. Conventional models and plaster casts may be provided for the more advanced work. The plaster casts may serve the additional purpose of room decoration. Much of the work now done makes little or no use of models, the modelling being more or less original on the part of the child.*

Kiln.

If the product is to be fired a kiln must be provided. At Montclair, N. J., the students evinced much interest in the building of a kiln in the school yard. Such a project is not always possible of execution and it then becomes necessary to provide a kiln to meet existing conditions. There are kilns on the market which meet school conditions. One of the best of these is known as the "Revelation" kiln. It uses kerosene oil as a fuel, and can be used for baking the clay and for glaze work. Four sizes of the kiln, suitable for school use, may be had at prices ranging from $50.00 to $95.00.

Potter's Wheels.

Much of the work in manual training serves the additional educational purpose of enlarging the child's comprehension of industrial processes. The purpose in clay modeling may be extended by introducing the potter's wheel. These wheels are of two general forms. One consists of a circular balanced board actuated by hand,

the other being propelled by the feet. A working drawing of the latter type is chosen in Fig. 3. A special form of hand-manipulated potter's wheel for children's use may be

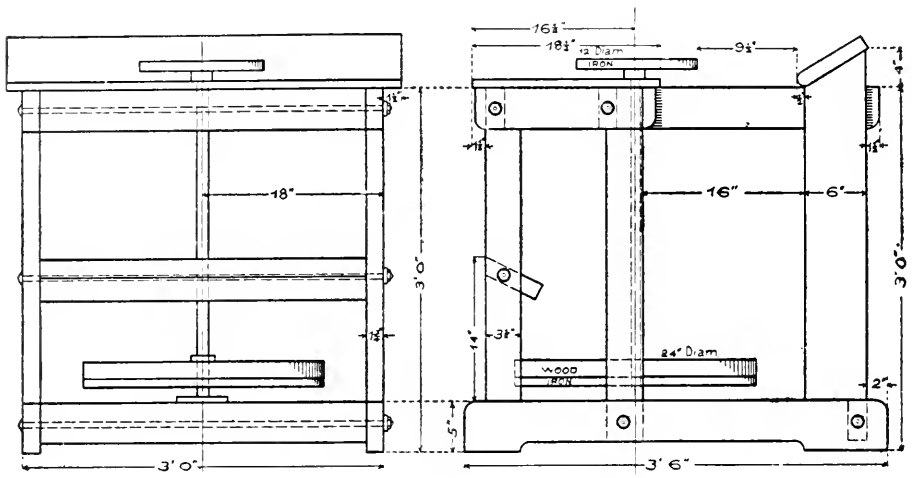


Fig. 3. Form of Potter's Wheel.

had on the market for $2.50. This price includes tin dishes, knives, wire, and trial package of clay, and the plate may be had either of eight-inch or ten-inch diameter.

Maintenance.

Clay costs, in most large cities, about one cent a pound in 500-pound lots, and may be procured at a pottery "worked-up." In the dry form, procurable at dealers in potter's supplies, clay costs from 1½ to 2 cents per pound. A principal item of expense in the use of clay in the schools is the labor involved in either reworking the old or preparing new clay for use. By washing and reusing the clay the total amount needed per pupil may not exceed two pounds. If the children are permitted to retain their work the cost of material may increase to perhaps 15 cents per pupil and upwards. Substitutes for

Fig. 4 Cardboard Construction in Regular Grade Room, Buffalo, N. Y.

clay cost about 25 cents per pound. If a kiln is used the cost of fuel must be added to the expense of maintenance.

Construction in Paper and Cardboard.

Construction in paper is a common form of manual training for the first three school years. The work is carried on in the regular class-room by the class teacher, and requires but a simple equipment (Fig. 4). No equipment is required at first, as the work is limited to folding. A pair of scissors for each pupil is all that is required for the next stage of the work. These may be had from $1.50 per dozen up. Scissors at $3.00 per dozen are advised, making the cost of equipment for a class of thirty pupils

amount to $7.50. In the more advanced paper work an additional equipment of pencil and ruler is generally supplied, involving a further outlay of 90 cents—estimating the pencils at 24 cents per dozen and the rulers at 12 cents per dozen—making a total cost of equipment for a class of 30 pupils in paper work at this stage, $8.40.

If the above equipment is used by but a single class, as in a private school, the cost per pupil is 26 cents. If, however, this same equipment is used by two or more classes, as in public school work, the cost per pupil for equipment is reduced to a much smaller figure. This method of duplicating the use of a single equipment may be practiced with advantage on the score of economy even to the extent of having an entire manual training outfit carried from grade room to grade room.

Varying practice in just such points as the above undoubtedly accounts to a degree for the discrepancy in the cost of equipment and maintenance as furnished by different schools.

Maintenance.

The cost of supplies for paper construction is small. Thin paper, either plain or colored, cut to the required size, is generally used at first, the work being limited to simple folding into box forms. Later, heavier papers, such as Manilla and cover paper, are introduced.

Papers are classified by wholesale paper houses according to the weight per ream; the commercial ream being quite generally 500 sheets. The sizes of the sheets vary. A quite general size is 22" x 28", from which dimensions the sizes differ a few inches either way. The weights of papers used in paper construction work range from 30 pounds to 80 pounds. A popular paper is that known to the trade as "cover paper," and used commer-

cially for the cover of booklets, catalogues, etc. It comes in a variety of pleasing shades. Any paper dealer will furnish sample books of these and other papers, giving sizes, weights, and cost.

Manilla paper ranges from less than one-half cent a sheet, for a 30-pound paper, to about 1¼ cents a sheet (22″ x 28″) for an 80-pound paper.

Cover paper ranges from one cent a sheet to 3½ cents a sheet for corresponding weights and size.

Bogus paper costs one cent a sheet (30″ x 40″).

White paste, obtainable in tubes, at five cents per tube, or, more cheaply, in glass jars, is used in joining thin paper, and liquid glue for thicker papers and cardboard.

Flour paste may be substituted for the paste supplied by dealers at a considerable saving in cost, and possesses the additional advantage of inculcating ideas of economy and self-dependence. On the method of preparing the paste, Mr. Arthur H. Chamberlin* says:

"Paste made from flour is much cheaper and is quite as good, if not superior, to that on the market. Mix a quantity of flour (sifted) with sufficient cold water to mold nicely; see that no lumps remain. This may be done by running the paste through the hand. Place upon stove and pour in boiling water, stirring at the same time. When the paste is of the proper thickness, remove the mixture without allowing it to boil. Add a few drops of oil of cloves to give pleasant odor. To prevent the paste from spoiling, add one grain of bichloride of mercury—mercuric chloride ($HgCl_2$). Stir well. $HgCl_2$ is a poison, hence care should be exercised when stirring in. When mixed, however, there is not sufficient strength for danger.

*Paper and Cardboard work.

"The paste may be kept nicely in the small glass jars with screwed tops that are purchased with library paste. Each pupil should be provided with a jar, and the covers should be on when the paste is not in use. The small brushes that come with the library paste are cheap and handy. They should be kept in water when not in use."

One or two boxes should be provided for the storage of scissors, and also for rulers and pencils. A paper cutter, costing from $3.00 to $7.00, will be found serviceable for cutting papers in quantity.

Returns from schools aggregating over 20,000 pupils give an approximate cost of maintaining construction work in paper at six cents per pupil.

Construction in Cardboard is a common type of work in the third, fourth and fifth grades, and is closely related in sequence with the work in paper. Papers weighing 100 pounds or over may be termed cardboard; 120-pound cardboard is suitable for class work. A form of white cardboard is known as Bristol Board, and a variously colored cardboard frequently used bears the trade name of Studio Mounts. Under the term of "construction work in cardboard" is here understood to include work with various substitutes for cardboard, such as Strawboard, Binder's Board, Jute Board, Manilla Tag, Press Board, Leatherette, etc. These various materials are used in giving a somewhat wider scope to the work, as in some form of elementary bookbinding. The work generally consists of the making of boxes, miniature furniture, miniature houses, picture frames, etc.

A somewhat more extensive equipment is required than for the work in paper. A suggested equipment for a class of thirty pupils is as follows:

30 Pairs scissors, at $3.00 per doz.	$7.50
30 Compasses	3.17
30 Rulers	.43
30 Triangles	1.75
2 Punches	.80
Total cost of equipment	$13.65

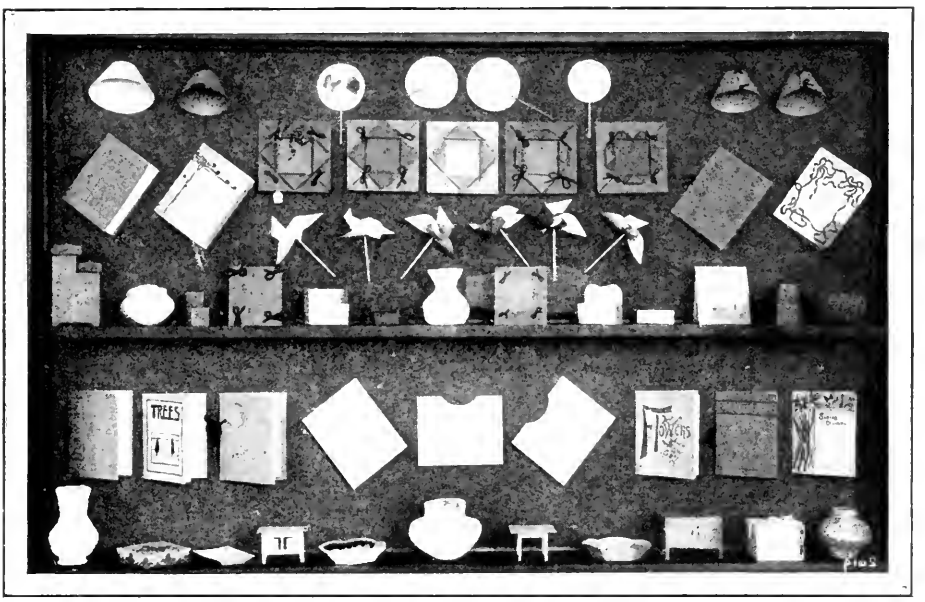


Fig. 5. Paper and Car Board Work, Buffalo, N. Y.

Maintenance.

Cardboard: 120 pounds to 500 sheets, 22x28, 90 cts. per 100 sheets.
Cardboard: 140 pounds to 500 sheets, 22x28, $1.00 per 100 sheets.
Cover-paper: 120 pounds 22x28, $2.64 per 100 sheets.
Straw-board: 20x24, $2.00 per 100 sheets.
Press-board (red): 80 pounds to 144 sheets, 24x32, 65 cts. per doz. sheets.
Binders' Board, 19½x26, 8 cts. per sheet.
Manilla Tag, 22x28, 120 lb., $1.50 per 100 sheets.
Oil Board, from size No. 00, 19½x23½, at $11.50 per ream, to size 2S, 20x32, at $15.00 per ream.
Leatherette, 20x25, plain, 2 cts. per sheet, or in 32 in. rolls, 25 cts per yard. Embossed costs about one-half cent a sheet more than the plain, and may be had in a variety of colors and patterns.

Glue, in glass bottles, at 10 cts. each or 75 cts. per doz.
Glue, in tubes, at 10 cts. each, or 88 cts. per doz.
Glue, in tin cans, from ¼ pt. at $1.80 per doz. to 2 qts. at $14.00 per doz.

The cost per pupil for cardboard work is but slightly higher than for paper work.

When purchased in large quantities at wholesale there is a considerable discount from the prices quoted for all materials in this book. Examples of the range of prices paid for materials used in construction work in paper and cardboard in one of the largest school systems in this country are here quoted from the "General Supplies" list issued by the Superintendent of School Supplies:

Board, straw, 9 x 12 in., 50 sheets to package, per package	.15¾
Cardboard, gray, 22 x 28 in., per sheet	.02
Compasses, without pencils, No. 1, per doz	1.00
Compasses, without pencils, No. 2, per doz	1.44
Compasses, without pencils, No. 3, per doz	.84
Cover paper, assorted colors, 20 x 12½ in., 100 sheets to package, per package	.44⅞
Glue, liquid, LePage's, 4-oz. cans, per doz	1.30
Leatherette, yellow, green, terra cotta and magenta, 10 x 12 in., 100 sheets to package, per package	.78
Paper, colored, 4 x 4 in., per package of 100 sheets	.06⅜
Paper, colored, 3 x 9 in., per package of 100 sheets	.11
Paper colored, 5 x 5 in., per package of 100 sheets	.11
Paper, colored, 6 x 9 in., per package of 100 sheets	.21
Bogus, 7 x 12 in., per ream	.17⅜
Cartridge, assorted, 14 x 18 in., 100 sheets to package, per package	.63⅘
Manilla, gray, 7 x 9 in., per ream	.13⅖
Manilla, gray, 8 x 10½ in., per ream	.17⅘
Manilla, gray, 9 x 11½ in., per ream	.22
Manilla, gray, 19 x 24 in., per ream	.99
Manilla, yellow, 7 x 9 in., per ream	.13⅓
Manilla, yellow, 8 x 10½ in., per ream	.17⅔
Manilla, yellow, 9 x 11½ in., per ream	.21½
Manilla, yellow, 19 x 24 in., per ream	.98

Note.—Basis of weight for gray and brown manilla drawing paper, 24 x 36, 65 lbs., 480 sheets to ream.

Oak tag, 7½ x 10 in., per ream..... .30½

Note.—Basis of weight for 7½ x 10 in., oak tag must be 24 x 36, 100 lbs., 480 sheets to ream.

Oak tag, 9 x 14 in., per ream..... .61¼

Oak tag, 24 x 36 in., per ream..... 4.05

Note.—Basis of weight for 9 x 14 in. and 24 x 36 in. oak tag must be 24 x 36, 120 lbs., 480 sheets to ream.

Paper, folding, size 4 x 4 in., package of 100 sheets, per package ..... .01½

Paper, folding, 5 x 5 in., engine-colored, assorted, 1,000 sheets to package, per package..... .17½

Paper, folding, heavy, 7 x 7 in., assorted colors, 100 sheets to package, per package..... .06¾

Paper, ¼ x 9 in., marginal strips, per package of 100..... .01⅞

Paper, sheets, 24 x 28 in., assorted colors, per sheet..... .02½

Paste, Higgins' liquid, in 14-oz. jars, per jar..... .28¾

Rulers, 12 in., brass edge, per doz..... .40

Triangles, wood, medium, 30 x 60 degrees, each..... .03½

Triangles, wood, 45 degrees, each..... .02½

Weaving.

Weaving, in various forms typical of primitive textile and basketry processes, is being introduced in many schools in the lower grades. The materials most used are strips of colored paper, yarn, rags, raffia, grass, and reeds.

Paper.

The weaving of paper mats is a part of the paper work considered on pages 15-21. A "Bogus-Paper Weaving Mat" has been devised by Miss Wilhelmina Seegmiller, Director of Art Instruction in the Indianapolis Public Schools, and may be had on the market, in pink, yellow, blue and gray, at $1.00 per hundred sheets. The following claims are made for these mats:

"As compared with the flimsy and strongly colored paper weaving mats in common use they have the following advantages:

"1. The material is so heavy and the strips so wide that the mats can be woven without the aid of a needle.

"2. The material has a roughness of texture and a softness of tone that are very desirable.

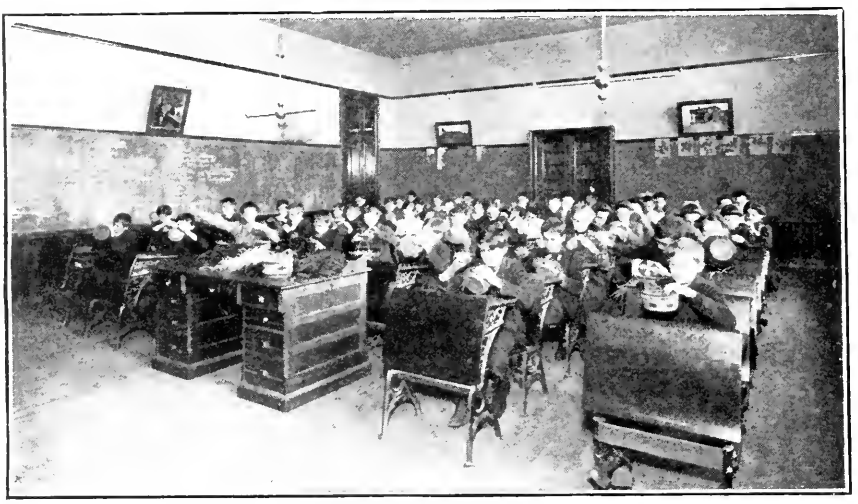


Fig 6. Basketry Class at Work Chicago Public Schools. *Vaughn*

"3. It takes crayon, pencil, ink or water color, which permits of an infinite variety of designs of the child's own creation being worked upon the mat after it is woven.

"4. The mat comes in one piece. The child first cuts the weft from the warp. The warp is then folded at right angles and cut along guide lines printed on the back. The weft strips are then cut apart and the mat is ready for weaving.

"5. The child has work in paper cutting, paper folding, and ruling in preparing the mat.

"6. In cutting his own strips the child leaves an "accidental" edge which is more artistic than the mechanical edge cut by machinery.

"7. The mat is large in size, being 8 x 8 in.

"8. The completed mat is an expression of the child's individuality and is substantial enough to be made into many simple objects such as baskets, popcorn holders, card cases, etc."

Yarn and Rags.

In weaving with Germantown yarn, carpet warp, and rags, some form of simple loom is used. In its simplest form this may be merely a rectangle of cardboard with notches cut into either end to carry the warp threads, or it may be a small wooden frame with a row of brads at either end. The making of these looms may be a part of the school work. A simple form of loom, with a cardboard heddle, may succeed the use of the above primitive devices, and may be made by the class in woodwork.

There are a number of school looms upon the market, for which various claims are made.

Faribault Loom	$.20
Needle	.05
Hammock attachment	.15
Complete	$.40
Todd Adjustable Hand Loom—	
White wood, hammock attachment, with needle	.35
Hard wood and metal attachment, No. 2, complete	.75
Needle	.05
Large adjustable loom, 20 x 32	3.00
Hooper Loom, with Needle	1.00
Large size, 18½ x 18½ (cherry)	5.00
Woolman Loom	1.50
Beadwork Loom	.50
Toy Knitter, 5 cts. each; per doz	.50

Weaving materials for loom may be had in a large variety of colors.

Cotton carpet warp, white, ½-lb. tubes	.15
Cotton carpet warp, colored, ½-lb. tubes	.18
Round chenille, per lb	.50
Jute, per lb	.25
Germantown wool, per skein	.20

Shoe laces, black, per skein	.20
Shoe laces, colored, per skein	.25
Rug yarn, per lb	.60

One pound of rug yarn will make eight rugs, 7 x 10 inches.

Raffia.

is the skin or outer coating of the leaf of a palm tree that grows in Madagascar. On account of its pliability and resistance to rotting when moist, it has been in use for a number of years for tying bunches of asparagus and as a gardener's twine. In recent years it has found marked favor as a desirable weaving material for school use. It is imported in braided plaits of between one and three pounds in weight, the strands varying in length from one and one-half to three feet. The plaits should be unbraided, soaked in water for about fifteen minutes, then shaken out and dried. This process will take most of the twist out and put the raffia in a better condition for use. Dealers in school supplies, and also many seedmen, carry raffia in stock. It is sold in the natural state and also dyed, either with aniline or vegetable dyes. By the single pound, natural raffia retails at from 15 cts. to 25 cts. per lb., and colored at from 40 cts. to 75 cts. A reasonable price would seem to be 50 cts. for the colored, and the following prices per lb. for the natural raffia, varying according to the amount purchased: 1 lb., 18 cts.; 5 lbs., 15 cts.; 10 lbs., 13 cts., and 100 lbs., 12 cts. One large school system pays 10½ cts. per lb. for natural raffia, and 28½ cts. per lb. for the colored.

Rattan.

in the form of flat strips and circular reeds of varying diameters, has long been a favorite material for basket weaving. The reeds of commerce are of certain standard diameters, and designated as Nos. 00, 1, 2, 3, etc.

The following table of prices is compiled from the prices quoted by seven different dealers:

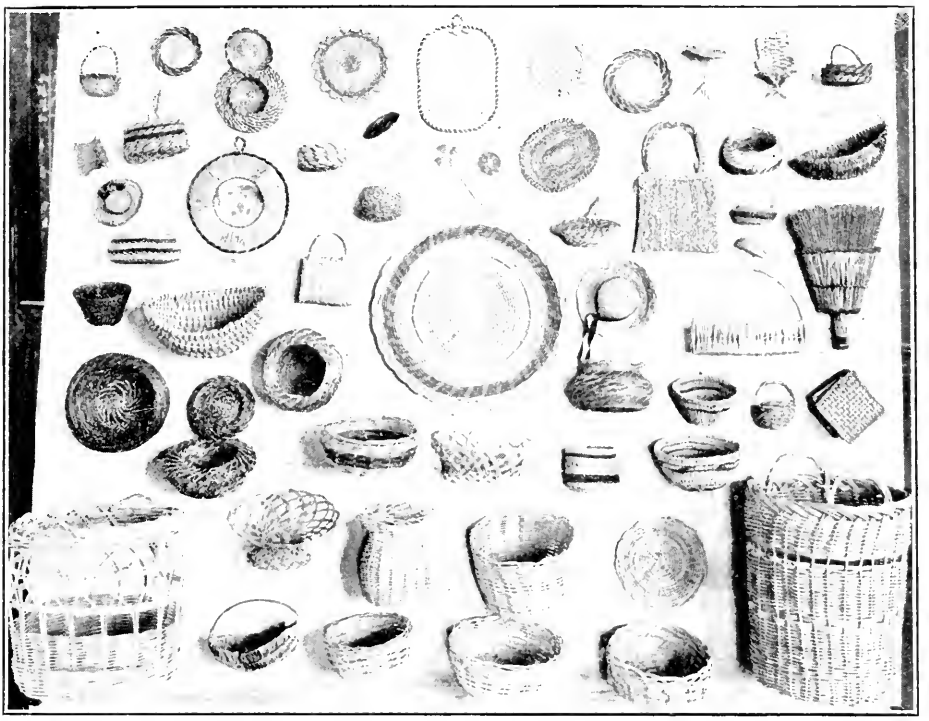


Fig. 7. Basketry Work.

Price per lb.

No. 1 Round.	No. 2 Round	No. 3 Round	No. 4 Round.	No. 5 Round.	No. 6 Round.	3-16 in. Flat.	5-16 in. Flat.
1.00	.75	.75	.75	.50	.50		
1.00	.85	.70	.60	.55		.50	.50
1.00	.70	.65	.60	.55	.45		
1.25	1.00	1.00	.95	.75	.70		
1.25	.95	.75	.75				
1.25	.75	.75	.75	.50	.45	.40	.40
.75	.60	.40	.35	.30	.25		

The last quotation is for lots of not less than five pounds of any one size.

Reeds are furnished to the schools of one of the eastern cities at the following prices per lb.: No. 1, 39 cts.; No. 2, 34 cts.; Nos. 3 and 4, 31 cts.

Among other basketry materials that may be purchased on the market are willow, pine needles (the long

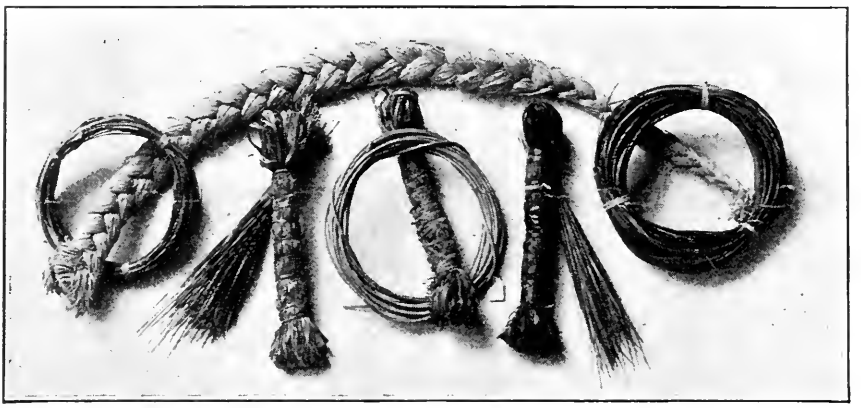


Fig. 8. Basketry Materials. *Vaughn.*

Southern variety), sweet grass, splints, palm, rush and braided straw.

Prices quoted are as follows:

Willow, selected, 8 to 12 cts. per lb.
Pine Needles, green and brown, 55 cts. per lb.
Sweet Grass, $1.00 per lb.
Splints, $1.00 per lb.
Palm, 35 cts. and 50 cts. per lb.
Rush, natural green, braided, 50 yds., 35 cts to 50 cts.
Straw, natural, braided, 120 yds., 35 cts. to 50 cts.
Straw, colored, braided, 120 yds., 60 cts.
Linen Thread, black and colored, for warp in Raffia weaving, per skein of 40 yds., 5 cts.

Many of the above materials may be gathered in the fields, as may also other grasses, stems, and leaves that are adaptable to basketry uses. Among these latter may be mentioned the bullrush, corn husks, the stem of the maiden-hair fern, and the numerous long grasses common to the fields and along the shores.

The collecting and use of vegetable dyes is admirably

treated in George Wharton Jones' book on "How to Make Indian and Other Baskets."

Bulletin No. 19, U. S. Department of Agriculture, Division of Forestry, on "Osier Culture," gives detailed information on the cost of willow and also the cost of

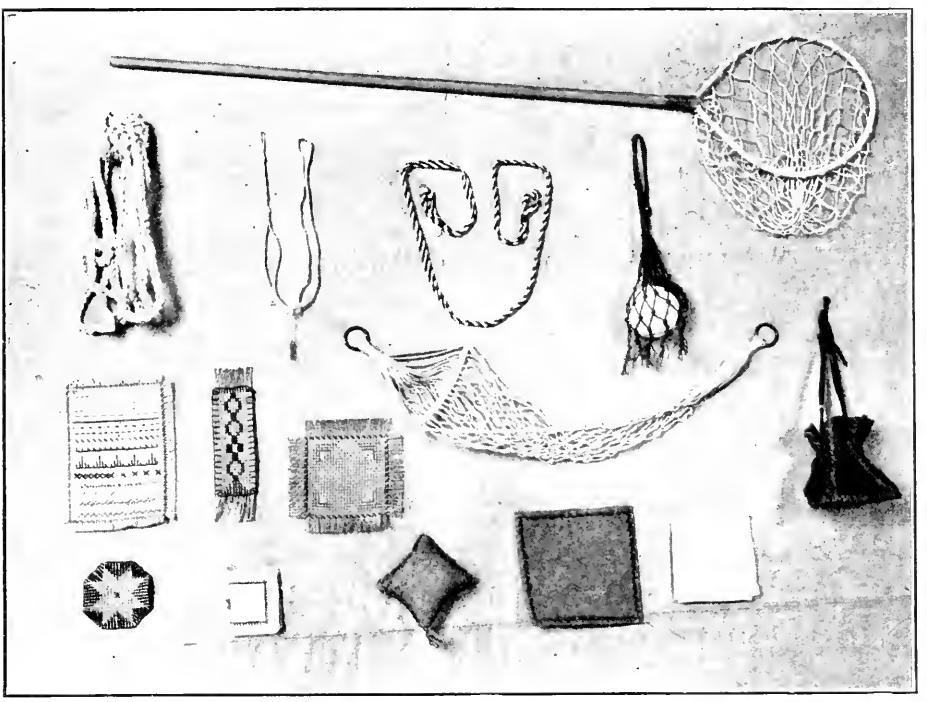


Fig. 9. Cord Work.

making willow baskets. The bulletin is for free distribution. The same department issues an illustrated book on "American Grasses," in three volumes, that will be found useful by a seeker for possible basketry materials.

Cord Work.

is somewhat allied to weaving and is sometimes introduced in the schools in the early grade work. Macrame cord costs from 25 cts. per pound upwards.

Sewing.

Sewing is often represented in a number of the grade classes and also in the high school. The earlier work is done at the pupil's desk (Fig. 10). Work of a more advanced character may be carried on in specially equipped rooms (Fig. 11). The equipment of a special sewing room is considered on pages 144–145.

The equipment for each pupil may consist of a work-box containing scissors, thimble, thread, cushion and pins, needles, measure, and emery, and costing from 50 cts. to 75 cts. per set.

Maintenance.

Miss Jessie Patterson, in an article in the *Outlook,* after describing a course in sewing, writes as follows regarding the cost of maintenance:

"It is very difficult to give an estimate of the cost per child for a course in sewing. The actual cost for materials required for the course in plain sewing, which is given above, is thirty cents, allowing nothing for waste. Pratt Institute allows about twenty cents for each pupil. This covers the course in hand sewing for six grades, twelve lessons in each grade of two hours in length, and includes all the materials used for the various exercises. Teachers College, five grades, ten cents a year, one lesson a week of one hour and twenty minutes. The allowance in the public schools of Brooklyn for ten months, one lesson of one hour each week (in addition to the plant of scissors, emeries, etc.), is twelve to fifteen cents per child. New York, six cents a year, in four grades, one hour each week. Philadelphia, six cents, where two lessons each week, of forty-five minutes each, are given in primary schools, and one each week of one hour in grammar schools. Washington, fourteen and a half cents (includ-

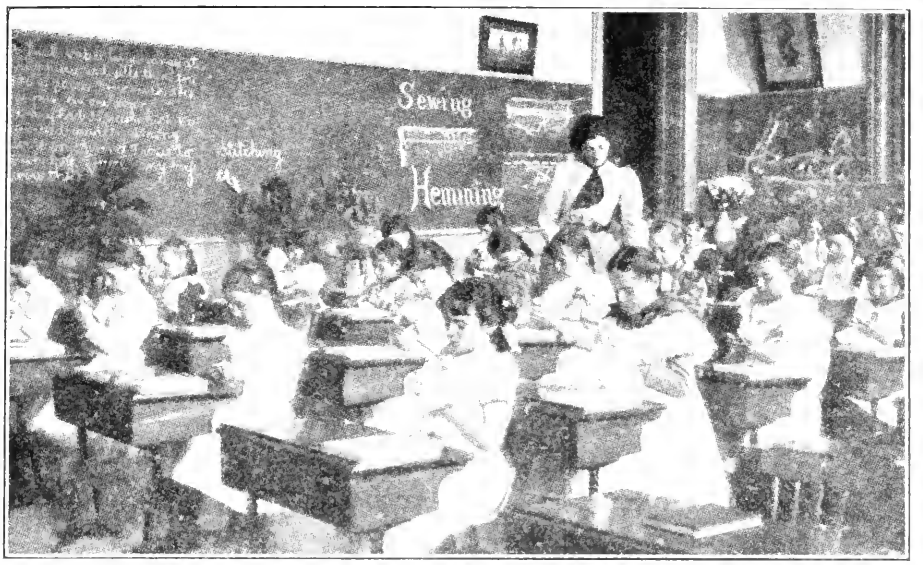


Fig. 10, Sewing in Regular Class Room, Washington, D. C.

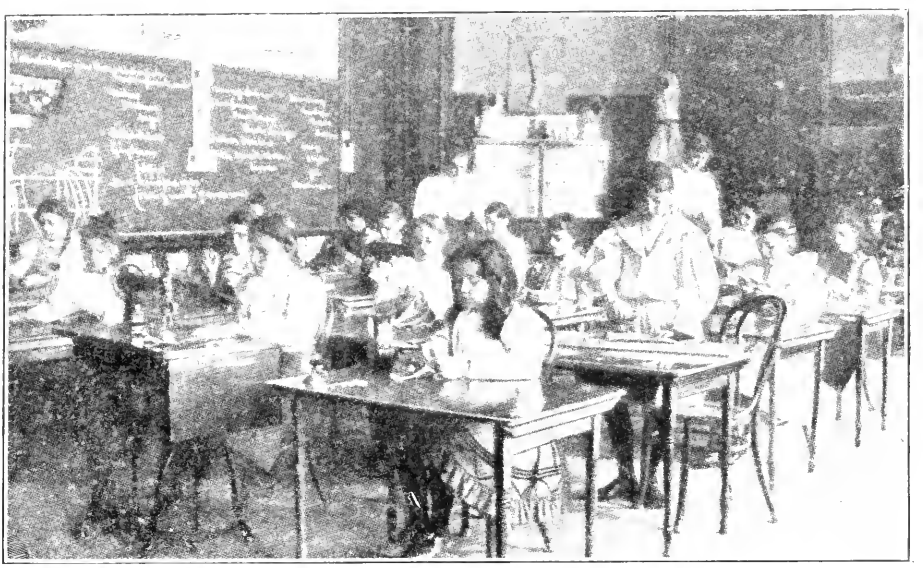


Fig. 11. Sewing in Specially Equipped Room, Public Schools, Washington, D. C.

ing implements, etc., as well as materials), one lesson a week of one hour and a half is given. Boston, two and a half cents are allowed, and the course of study requires that in three classes of the grammar grades instruction shall be given for two hours each week. Minneapolis, eleven and a half cents. Cleveland, five and a half cents. In Boston and Philadelphia, children bring material from home."

The concluding line in the above paragraph suggests an important factor in the consideration of the cost per pupil for sewing. A very important question here, as in all other work, is whether the work consists in copying a set of models or in the use of sewing in natural relations to the school interests.

A detailed statement of the kind, amount, and cost of the materials actually used in the work in sewing, cord work, and basketry by the pupils of the Horace Mann School, New York City, in the first, second, third, sixth, and seventh grades during the school year of 1900-01 is here given. This work was closely correlated with other studies, especially with nature study, reading and history.

Burlap, 2¾ yards, at 75 cts. per yard	$2.07
Java canvas, white, 3 yards, at 38 cts. per yard	1.14
Java canvas, colored, 3¼ yards, at 45 cts. per yard	1.46
Unbleached muslin, 10 yards, at 8 cts. per yard	.80
White muslin, 4 yards, at 9½ cts. per yard	.41
Victoria lawn, 4 yards, at 20 cts. per yard	.80
Linen lawn, 1 yard	.90
Heavy lawn, ⅛ yard, at 75 cts. per yard	.10
Long cloth, 12 yards, at 12 cts. per yard	1.44
Gingham, ½ yard, at 12 cts. per yard	.06
Flannel, ½ yard, at 60 cts. per yard	.30
Eider flannel, ½ yard, at 55 cts. per yard	.28
Ribbon (different widths and different colors), 1 piece, at 45 cts.	.45
Worsted (different colors), 1¼ pounds, at $1.45 per pound	1.82
Cord, 10 pounds, at 16 cts. per pound	1.60
Iron rings, ½ gross, at 60 cts. per gross	.30

Brass rings, ½ gross, at 15 cts. per gross	.08
Raffia, 18 pounds, at 15 cts. per pound	2.70
Birch bark (Christmas), 20 square feet, at 12 cts. per square foot	2.40
Chamois skins penwipers and moccasins, 4, at 25 cts. each	1.00
Rattan, 15 pounds, at 35 cts. per pound	5.25
Rattan, 10 pounds, at 60 cts. per pound	6.00
Bobbin, 1½ dozen, at 10 cts. per dozen	.15
Pearl buttons, 3½ dozen, at 12 cts. per dozen	.42
Lace torchon, 3 yards, at 10 cts. per yard	.30
Lace, val., ½ piece, at 25 cts per piece	.13
Stockinet, 1 yard, at 8 cts. per yard	.08
Darning cotton, ⅔ ball, at 3 cts. per ball	.02
Diamond dye, 6 packages, at 10 cts. per package	.60
Braid (dolls, different colors), 1 piece, at 5 cts. per piece	.05
Braid (gold), 7 yards, at 5 cts. per yard	.35
Buttons (gold), 1 dozen, at 15 cts. per dozen	.15
Cotton thread (approximate amount), 1 dozen spools, at 41 cts. per dozen	.41
Silk thread (approximate amount), ½ dozen spools	.54
Needles, sharps, 1 dozen papers, at 48 cts. per dozen	.48
Needles, tap, ½ dozen papers, at 48 cts. per dozen	.24
	$35.28

The above materials were used by 165 pupils, making the cost per pupil about twenty-five cents.

The following data for the cost of sewing equipment and maintenance is furnished by the experience of the Indianapolis Public Schools:

Equipment for 60 pupils	$54.00
Maintenance, 656 pupils, 1 hour per week for 34 weeks	117.35
Cost per pupil	.18

acuse Public Schools—Report 1901:

Sewing supplies for 581 pupils	137.41
Cost per pupil	.23

Bent Iron Work.

Bent iron work is adapted for the fourth, fifth, sixth and seventh grades. It may be carried on in the regular class room, or in a special metal working room. In the former case a work bench, such as supplied for the wood-

working shop, or a table of strong construction, may be added to the regular class-room equipment. One or two anvil vises should be clamped to the bench or table, thus

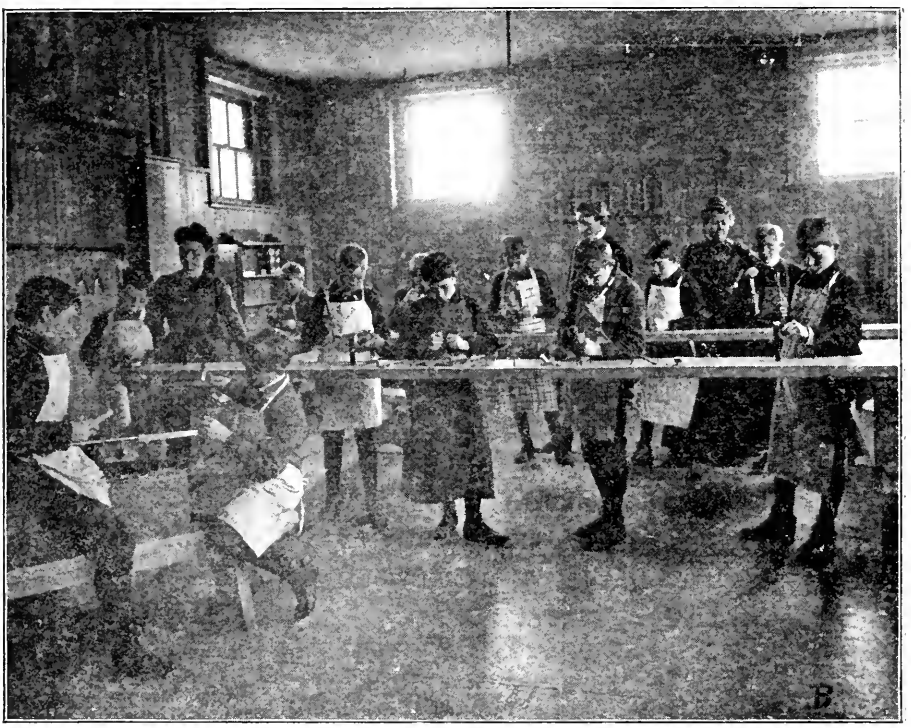


Fig. 12. Bent Iron Work in Special Room with Simple Equipment, Buffalo, N. Y.

affording an opportunity for the heavier work in riveting and forming. The special metal-working room is the ideal equipment, and may be used for all forms of simple metal working in which tin, sheet copper, brass, lead, and iron are the materials used. The equipment of such a laboratory is given on pages 131–134.

Venetian iron is a band iron of widths varying from ⅛″ to ⅜″ and 1-32″ thick. This thickness permits of ready bending with small pliers. A substitute may be made by cutting into strips No. 22 guage sheet iron.

Strips when crossing each other may be fastened together either by riveting or tying with fine wire. A small nail-set may be used to punch rivet holes or a "universal punch," cutting a hole to match the rivet. Strips, extending in the same direction, may be fastened by riveting, but a better method for class work is to employ small U's of the iron, known as "binders." These binders are supplied by dealers in sizes to correspond with the varying widths of strips.

Metal Snips are used for cutting the strips into the required lengths. No. 9 is a serviceable size. One "Rolling-Cutter Shears" placed in a class-room will be found valuable for shearing purposes. Each child should be supplied with a pair of 5-in. round-nose pliers and a pair of 5-in. square-nose pliers. For riveting, one or more anvils should be provided, and a table or bench to clamp them to. An 8-oz. riveting hammer may be used.

In the fourth and fifth grades work may be limited to bending and fastening with binders, and will call for a minimum equipment.

Equipment for Class of Thirty Pupils.

30 Flat-nose pliers, No. 5, at $2.04	$5.10
30 Round-nose pliers, No. 5, at $2.04	5.10
1 Cutting machine	4.75
30 Rulers	.30
Total cost of equipment	$15.25

Cost of Maintenance for Class of Thirty Pupils.
(Horace Mann School, N. Y. City.)

Binders, at 10 cts. per 100	$2.80
¼-inch iron at 21 cts. per coil of 50 feet	2.10
Black paint at 25 cts. per tube	.50
30 Pencils	.60
Total cost of maintenance	$6.00
Cost per pupil	.20

For the work in the upper grades the cost of vises, hammers and snips must be added to the above equip-

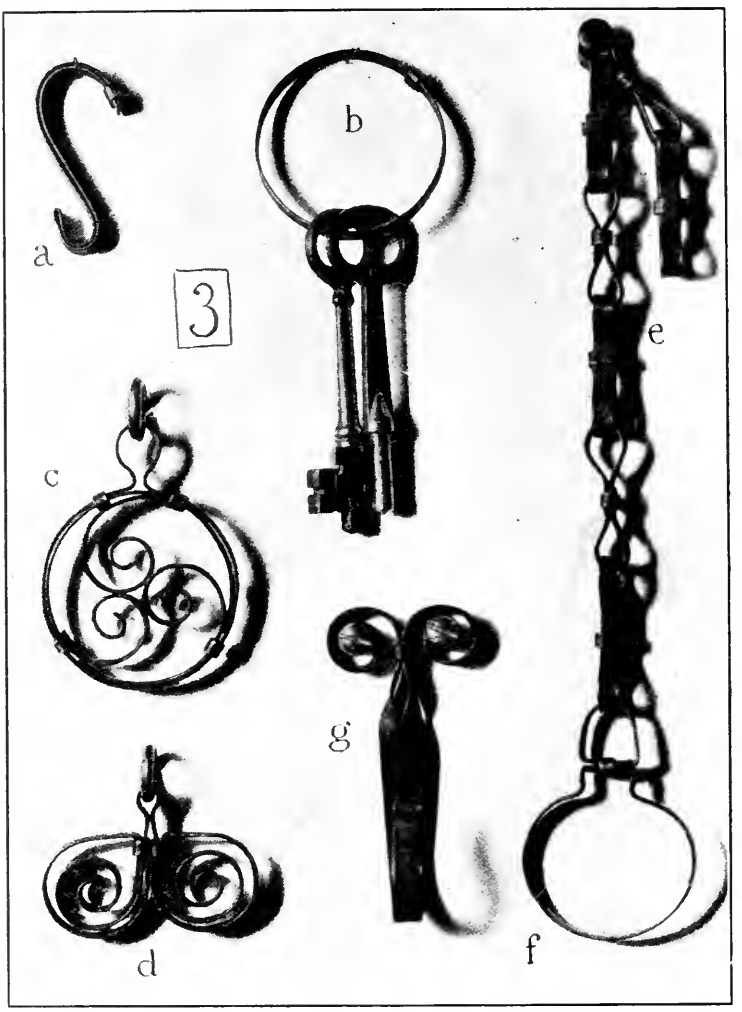


Fig. 13. Bent Iron Work.

ment estimate. The prices may be obtained from the following price list of Venetian Iron supplies:

Riveting hammer, 8 oz.	$ .35
Flat-nose pliers, No. 5	.20

Round-nose pliers, No. 5	.20
Metal snips, No. 9	.90
Clamp vises, from 1½ in. jaws, opening to 1¾ in. at 30 cts., to 2½ in. jaws, opening to 2¾in., at	1.40
Roller-cutter shears, No. 11; will cut No. 20 iron; each	4.75
Iron in strips, per coil of 50 feet, ⅛-in.	.16
Iron in strips, per coil of 50 feet, 3-16-in.	.18
Iron in strips, per coil of 50 feet, ¼-in.	.21
Iron in strips, per coil of 50 feet, ⅜-in.	.25
Binders, per 100	.10
Black paint, per can	.35
Black paint, per tube	.25

The following quotation from an article on "Venetian Iron Work in the School*" by Daniel Upton, Supervisor of Manual Training, Buffalo, N. Y., is suggestive of a method for utilizing waste materials in increasing the possibilities in Venetian iron work:

Allied Materials.

"Along with the iron, tin may be used as parts of various projects, and, of course, glasses, jardinieres, and other receptacles will be brought from home and will afford an opportunity for designing and making proper supports. Some of the most interesting exercises are those in which the class takes an object which has hitherto been considered useless, and by their handiwork create from it a thing of beauty and usefulness. Broken goblets, baking-powder cans and covers have been reclaimed from the garbage barrel and have emerged from the hands of our youthful workers as pansy glasses, flower-pots, or pin-trays—an excellent training in thrift. * * * In the Buffalo schools this work is done in the seventh grade. There has never been any lagging of interest in a class, and not one where the teacher could not notice marked improvement in the individual work and in power for both independent planning and execution. Twenty regu-

*Manual Training Magazine, January, 1903.

lar grade teachers are giving lessons to their classes, and special teachers instruct probably as many more; and the writer, from the experience and observation mentioned, feels abundantly warranted in recommending this

Fig. 14. Simple Wood Work with Knife in Regular Class Room, Buffalo, N. Y.

medium both on account of its educational value and its economy."

Knife Work.

Knife work or whittling is frequently carried on in the fourth and fifth grades. The meagreness of the required equipment recommends it from the cost point of view. Stated in its lowest terms the equipment consists of a jack knife. School conditions impose a few additions. Provision must be made to protect the desk. A

slab of hard wood about a foot square may serve this purpose. This elemental means has been elaborated into a desk cover, which adds to its purpose of protecting the desk the furnishing of a receptacle for tools and instruments and forming a unit of equipment that is readily handled and stored. Dealers in manual training equipments supply various types of such desk covers. One such is shown in Fig 15, and is so constructed that it will not slip or mar the desk when in use. The tray is 12½

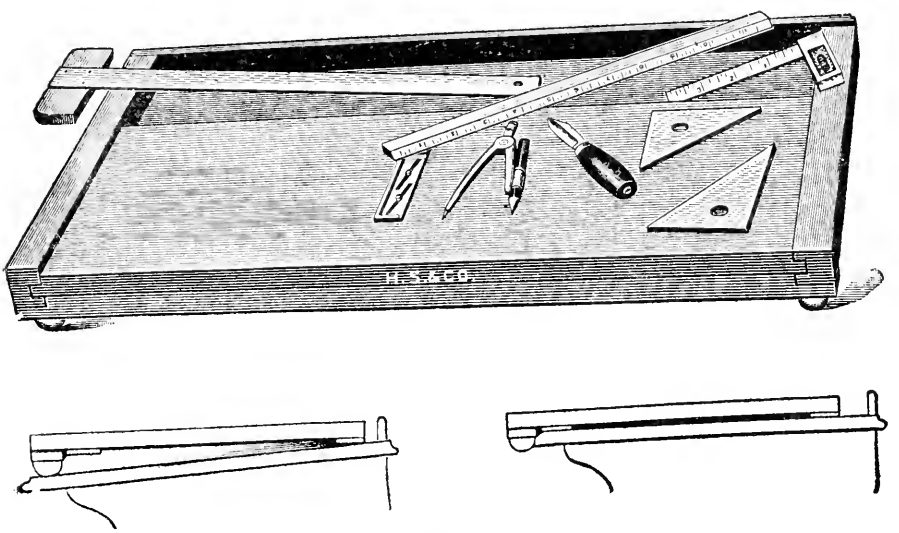


Fig 15. Whittling Tray.

x 22 inches, with a recess of 4 x 20 inches to hold the tools. It is provided with a unique and very practical clamp which will hold a block up to nine inches in width. This tray is furnished with a set of tools especially adapted for elementary knife work, consisting of a No. 7 Sloyd knife, a pair of compasses, two triangles, a T square, a foot-rule, and a 4-inch try-square. The tray, without tools, retails at $9.00 per doz., or 90 cents each. The tools enumerated above retail at 8.50 per dozen sets, or .85 per set.

A cabinet for the storage of trays must be provided. In design it may be similar to a cabinet for the storage of drawing-boards; that is, having its upright partitions slightly wider apart than the narrower width of the tray and having cleats along which the tray is slipped into place. It may be mounted upon casters to permit of its being moved from room to room.

The success of knifework is largely dependent upon the kind and quality of knife used. Upon this point Mr. Frank H. Pierce* has said a word worthy of the consideration of those contemplating the selection of a knife for this work.

"The knife should be selected with great care, no matter how extensive or how meagre the rest of the equipment. In selecting the knife there are a number of points to be considered. The quality of the steel should be of the best, and the blade carefully tempered so that it will hold a keen cutting edge. If the temper is too hard the edge will nick and break, and if too soft the edge will turn over, giving a great deal of trouble and doing poor work. The construction of the knife should be good, and the design such that it is well adapted to the work to be done and to the capacity of the user. There are a number of styles of knife which are used for this work, the ordinary two-bladed pocket-knife, or jack-knife; the round-handled knife with the fixed blade; the sloyd-pattern knife with a flattened handle and a fixed blade. Of these three styles of knife the sloyd-pattern seems to be the best adapted to schoolroom work. The pocket-knife has the disadvantage of closing. This is not desirable in a school knife, as it makes it easy to slip into

*"The Manual Training Knife"—Manual Training Magazine, April, 1903.

the pocket. No temptation should be offered to take the knife from the schoolroom, either by accident or design. Another objection to the pocket-knife is that the blade has a thin edge, making it hard to keep in order. The second form of knife has a wide blade, ground from the edge to the back, making it very hard to whet properly. The blade of this style of knife is fastened to the handle by being driven into it. After a short time the blade gets loose and pulls out. In the sloyd-pattern knife most of the objections to the foregoing styles are overcome. This style of knife will not close up; the blade has a thick, strong back, and is ground from the edge to the center, insuring a strong cutting edge; the point of the blade is strong and centrally located; the blade is fastened to the handle by a tang, which runs completely through and is riveted on the end, thus holding it firmly in place. These knives are made in several sizes, but the most suitable one, for young workers, is the size with a two-and-one-half-inch blade. This knife is large enough for all school work, and is well suited to the use of little hands. A great mistake is made in selecting too large a knife. A large knife is clumsy, and in making small concave cuts, where the point must be used, the fingers are apt to close upon the edge of the blade and get cut.

When the knife first comes from the maker it is not in condition to do good whittling; it has what may be termed a commercial edge; that is, the edge is ground quite bluff, so that it will not be easily damaged while in stock. The first thing before using the knife is to whet it to a thin keen edge.

A good oilstone is an absolute necessity. The India oilstone of medium grade will be found to give the best satisfaction of any stone on the market."

In order to lay out the work a simple set of drafting instruments is required, consisting of two triangles, T square, compasses, ruler, and pencil. A try square is also required.

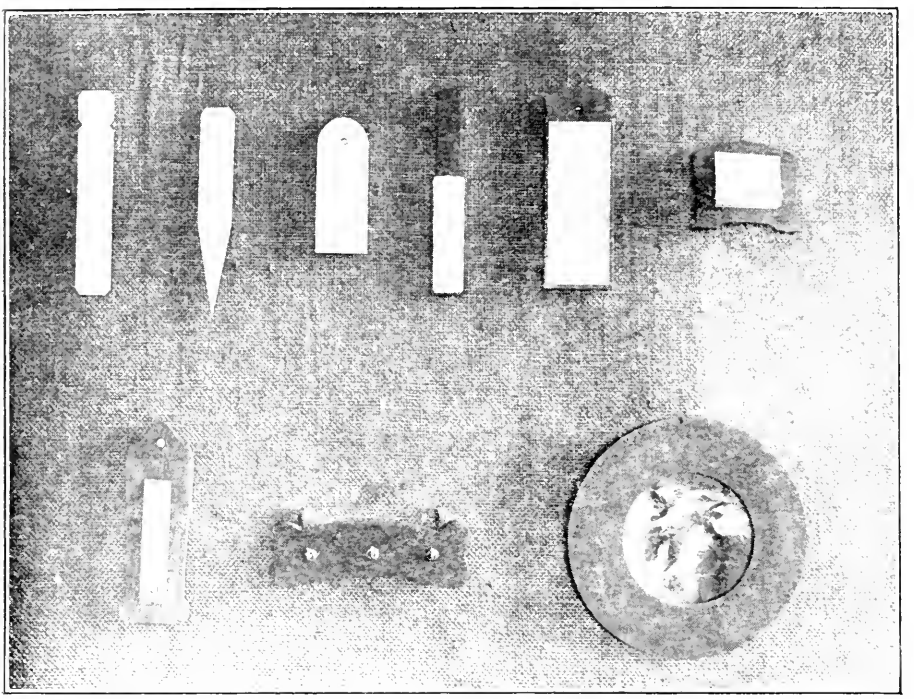


Fig. 16. Knife Work.

Individual equipment for class of thirty pupils:

30 Sloyd knives at $4.05 per dozen	$10.13
30 6-inch try squares, at $1.58 per dozen	3.95
30 compasses, at $1.00 per dozen	2.50
30 T squares, at 63 cts. per dozen	1.58
30 45 degree triangles, at 50 cts. per dozen	1.25
30 30 degree, 60 degree, triangles, at 50 cts. per dozen	1.25
30 rulers at 12 cts. per dozen	.30
30 pencils at 24 cts. per dozen	.60
30 trays at $8.10 per dozen	20.25
Total cost of individual equipment	$41.81

The scope of the work may be enlarged by the addition of the following general equipment:

6 brad awls	$ .19
6 hammers	1.80
6 grooving tools	1.50
4 fret-saw frames	2.60
4 dozen fret-saw blades	.32
1 ¼-inch auger and bit	1.25
1 small back-saw	.82
12 6-inch hand screws	2.00
1 India oil stone and can	.90
1 honing strop	.25
Total cost of general equipment	$11.63
1 cabinet, estimated	20.00
Total cost of complete equipment	$73.44

A box, suitably partitioned, containing an outfit for a class of twenty in whittling, can be purchased from dealers in manual training supplies. The outfit contains twenty each of the following: rule, pencil, compasses, sand-paper block, try-square, and knife, and also a chart of models. The retail price is $15.00. A chest containing the following general tools and supplies retails at $7.00: saw, oil stone, 2 honing strops, 6 auger bit gimlets, hatchet, oil can, and 2 quires of sand paper.

Maintenance.

Basswood, in thin pieces, is the material recommended for this kind of work. It does not split too easily; is soft, and is uniform in texture. Whitewood (poplar or tulip tree) may be used. White pine may also be used to advantage. The wood may be purchased in the rough, or cut to size, from a mill, or may be had of dealers in kindergarten supplies, who furnish the materials cut to a large variety of sizes.

Basswood, ⅛″, 3-16″ or ¼″ thick, can be obtained in pieces 4″ x 9″ at $1.00 per hundred.

No. oo sand paper at 20 cts. per quire.
Glue, at 25 cts. per can.

The cost per pupil for maintenance is about ten cents.

If designs in color are placed upon the work the cost for the oil colors must be added to the cost of maintenance. Tubes of ivory black, burnt umber, light red, prussian blue, and crown yellow, may be had at five cents per tube. In addition to the colors it will be necessary to provide dishes for mixing the colors, and small brushes for laying them on.

Bench Work in Wood.

Up to this point the question of the cost of equipment has not been a serious one, nor one acting as a factor to give pause to the introduction of manual training. Beginning with the bench work in wood and continuing through the high school work, the cost of the initial equipment becomes a matter of much moment and deserving of considerable thought and study. Specially fitted rooms have now become a necessity, as have also special teachers.

In What Years?

By referring to Table A—(Opp. p. 7.)it will be seen that bench work in wood—tabulated as "J"—is usually carried on during the last two years of the elementary school and during the first year of the high school. Some schools introduce the work a year earlier, and it is also quite extensively carried on in the second year of the high school. This latter practice is partially accounted for by the lack of an equipment for other manual training subjects usual in a completely equipped manual training high school. The best practice would seem to limit this subject to the first year of the high school and the two years immediately preceding.

Teachers.

A special teacher is required for this work and for the various subjects succeeding. The demand for such teachers has been in excess of the supply, with the result that in many instances recourse has been had to the artisan as well as to graduates of the engineering schools for teachers of high school manual training subjects. The artisan, though versed in the technic of his trade, is apt to have but a vague conception of the requisites of a teacher, and the results of his attempts to teach may possibly serve as an argument for the opponent of manual training. The experiment of appointing engineering graduates as teachers of manual training subjects has been happier. He has "been through the shops" albeit the *motiv* of his shop instruction is not that of the manual training school. But on account of the thoroughness and scope of his education he is capable of adapting himself successfully to the requirements imposed by high school conditions. This class has furnished many of the most successful teachers and supervisors of manual training. Another source of supply for teachers is found in the graduates of manual training schools.

But the source that may be looked to for the best trained teachers is the normal school or college having a manual training department. In the best of these teachers are broadly trained for the peculiarly exacting demands made upon them. Nor does this source limit itself to supplying teachers of shop work. Thorough and efficient training is also given for teachers in the domestic arts and sciences.

In order that the problem of a suitable equipment for bench work in wood may be comprehensively approached and intelligently dealt with the following

scheme of an analysis of the factors entering into the problem is suggested.

Shop for Bench Work in Wood.

General considerations:—
- In new building.
- In old building.
- Situation with relation to other classrooms.
- Size.
- Doors.
- Lighting:—
  - Natural.
  - Artificial.
- Auxiliary rooms:—
  - Demonstration room.
  - Wash room.
  - Storage room.
  - Teacher's room.

Lay-out:—
- Bench space:—
  - Distribution of benches.
  - Relation to light.
- Bench:—
  - Construction.
  - Equipment.
- Demonstration space:—
  - Bench.
  - Seats.
  - Blackboard.
- Glue and stain bench:—
  - Construction.
  - Equipment.

Metal working bench: —
    Construction.
    Equipment.

Display panels for:—
    General tools.
        Tools for same.
    Specimens of woods, cones, etc.
    Exhibition of typical course.
    Bulletins.

Storage for:—
    Lumber.
    Finished work.
    Work in process of construction.
    Nails and screws.
    Blue prints.

Decorations.

Before considering each of the above factors in detail it may be well to define a general method of approach to the problem as a whole. It will be appreciated that certain determinate factors are almost invariably to be encountered in all problems of this nature; factors limited by uncontrollable conditions. It would be impossible to consider all such possible factors and to provide or suggest a solution for each problem affected by them. The best that may be done under the circumstances is to lay out an equipment representative of the best practice. to suggest modifications to meet various conditions, and then permit the reader to gather from the information given such data as may be applicable to his special needs. In this spirit is the following detailed consideration given of the above analysis of our problem.

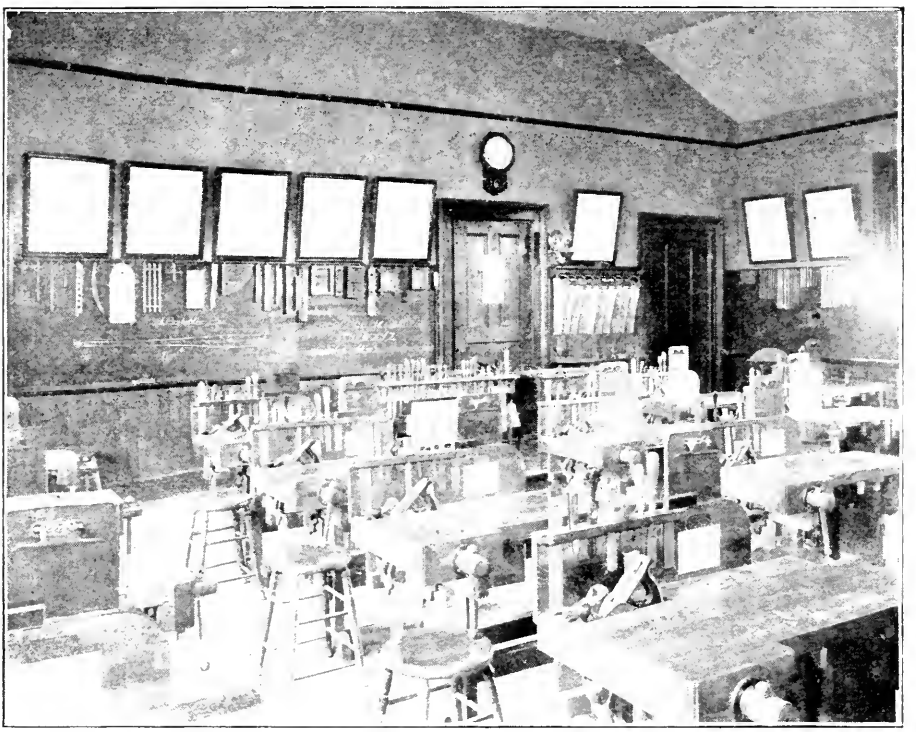


Fig. 17. Wood Working Equipment for the Elementary School, Westbrook, Me.

General Considerations.

The first general consideration is whether one is called upon to plan a room in a building yet to be erected or to utilize a room in an existing building.

In New Building.

In the former case the architect may be furnished with data relating to the size of room, auxiliary rooms, position of doors, relation of the room to other class rooms, the lighting of the rooms, and the details of shelving, cabinets, and all other equipment furnished under architect's specifications. Suggestions for this information will be found below.

In Old Building.

In the case of utilizing a room in an existing building it becomes necessary to conform to the conditions as one finds them.

Relation to Other Classrooms.

The situation of the wood-working room with relation to other classrooms is primarily a question of the inter-relation of the shops as a whole and their relation to the other classrooms and laboratories. By one plan the shops may all be grouped together in a separate, connecting building, or they may be confined to a wing of the building. The determining factors in this conclusion are the concentration of the use of power, the isolation of noise incident to shop work, and the vibration caused by the machinery. By placing all shops using power as near as possible to the engine-room not alone economical equipment is attained but also some saving in maintenance. The floor plans shown on pages 163–165, 167–170 may be found suggestive on this point.

If no power is made use of in the wood-working room its status then becomes that of any other classroom, and its position is subject to much the same considerations. A common practice in the new public school buildings in New York City, where but one room is devoted to bench work, is to place that room at the top of the building.

Size.

The size of the room is determined by the number of benches to be installed. Assuming an allotment of 24 benches, a room 30-ft. x 40-ft. will meet all requirements.

Doors.

The factors determining the position of the doors are dependent upon the easy ingress and egress of the students, and the relation of the room to halls and other classrooms.

Lighting.

Abundant light is a prime requisite for shop-work, therefore a corner room is more desirable than one having windows on but one side. In a high-studded room, the placing of the windows four or five feet from the floor will afford an opportunity for a maximum wall-space for display of panels, etc.

Where it is necessary to provide artificial light, drop lights should be placed at the back left-hand corner of each bench, as well as elsewhere about the room where occasion demands.

Auxiliary Rooms.

Demonstration Room.

It is customary to set off a part of the wood-working room for demonstration purposes. Under "demonstration space," below, such an arrangement is considered. A departure from this practice is exemplified in the new building of the Ethical Culture Society in New York City. In planning the equipment for bench work provision for demonstration was made by allotting a connecting room for this purpose. The room is fitted up much as an ordinary classroom, with chairs provided with armrests, teacher's desk, and demonstration bench. A novel feature of the equipment is a swinging blackboard fitted into the wall separating the bench-room from the demonstration-room. The working-drawings of the particular piece of work being demonstrated, are drawn upon the blackboard, and upon the passing of the class into the bench-room, the blackboard is swung about a central pivot, and the drawings then serve as working-drawings for the class at the benches. The demonstration-room now becomes available as a regular classroom, if such use is required.

Wash Room.

Provision should be made for the storage of shop-clothes and for washing-up. In the wood-working room, as an apron is the only additional piece of clothing used—and even this is frequently dispensed with—the apron may be put away in the locker provided for unfinished work.

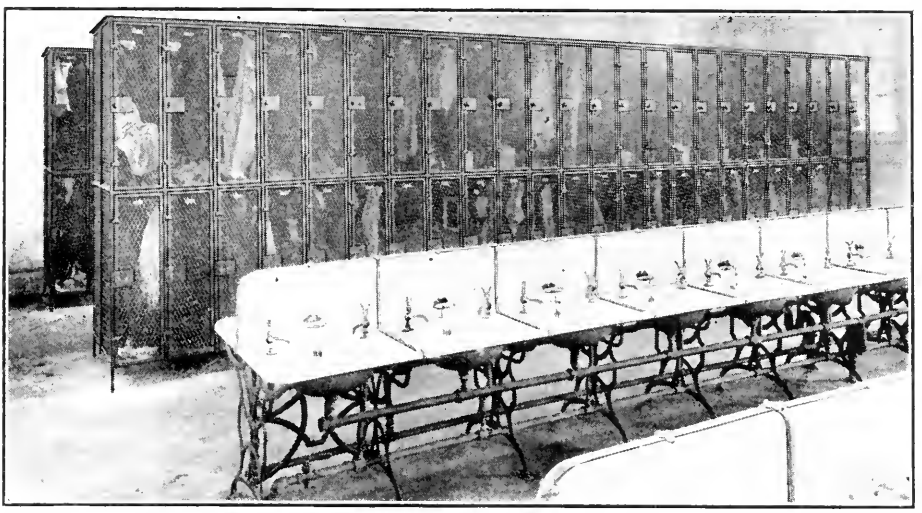


Fig. 18. Lockers and Wash Room.

In the general locker arrangement, however, provision should be made for a locker for each student. These lockers may be arranged along the walls of a small room in the centre of which facilities for washing-up may be provided. (Fig 18.) A series of individual wash-stands, of the standard types furnished on the market, may be installed, or the typical shop practice of a long double trough may be followed. Hot and cold water, soap and soap-receptacles, roller towels, and mirrors should be provided. There is less need for a wash-room in connection with the wood-working shops than in the case of the metal-working shops.

Storage Room.

A separate room about 15-ft. x 18-ft. for storage purposes is desirable but not indispensible. All necessary materials may be stored in the shop. Lumber may be stood on end, the various sizes and kinds being separated by pegs, and a portion of the wall space set aside for this purpose. However, the assigning of a separate room is recommended. The fittings for such a room are simple. Along one side of the room may be arranged three rows of pegs each peg about fourteen inches in length, and the pegs about a foot apart. The first row should be placed eighteen inches from the floor, the next three and one-half feet from the floor and the top row eight feet. This arrangement will permit of different lengths and varying kinds of boards being stood on end and resting between the pegs, and also of the ready selection of any required board. Along another wall might be arranged a nest of pigeon-holes extending from the floor to the ceiling, affording storage for cut-up material, for hardware, and for general storage purposes. 9″ x 18″ x 18″ depth will be found a serviceable size for the pigeon-holes. If power is to be had, a circular saw may be placed in this room to cut up the lumber into sizes suitable for class use.

Teacher's Room.

A room about 8 ft. x 10 ft. may be assigned for the teacher's use, and furnished with a desk and a cabinet for the filing of blue prints, magazines, books, etc. One wall may be fitted with pigeon-holes as suggested above for the storage-room. This latter provision is especially desirable if there is no separate storage-room.

Lay Out.

Two important considerations underlie the layout of a work-room—economy of space and such an inter-re-

lation of its component factors as may give a maximum of efficiency with a minimum of movement and friction.

The reason for economy of space is a general and obvious one. The reason for the second consideration may not be quite so apparent. Its appeal is one for economy of exertion both upon the part of the teacher and upon that of the student. For example, it would bespeak poor judgment in the layout of a room, if the general tools were all kept in the storage-room, necessitating a considerable distance for each student to travel every time he wanted to make use of a general tool, when such tools might be conveniently placed on a large panel situated midway on the wall space nearest the benches.

By the component factors is meant the various benches—students', demonstration, stain, and metal-working,—display racks, cabinets, and all other furnishings included in the equipment of the shops. It is the interrelation of these various factors, that is, their distribution with relation to each other, as well as their relation to the windows, doors and form of the room, and also their construction and cost that now demands our attention.

A simple device that may be of aid in facilitating the problem of the best arrangement of benches in a room, is to make a scale drawing of the room—say, on a scale of ½-inch to the foot—showing the position of all windows, doors, and posts, and cutting out of paper, to the same scale, the space occupied by each bench and other pieces of furniture. The pieces of paper may then be arranged and rearranged upon the scale drawing of the room until the best disposition is determined upon. Or the problem may be solved mathematically by figuring out the space occupied by each piece of furniture, aisle space, and other factors entering into the problem, and making a lay-out drawing conformable to the conditions.

Benches.

The benches should be placed in the best lighted portion of the room and also so that the student faces the maximum light when working. There should be space enough left between the benches so that the student has free play and that the teacher may have ready access to each bench while the class is at work. Aisle space of sufficient width to accommodate students in habitual lines of travel to and fro from the benches should be provided, and is dependent upon the form of the room. The minimum of space that should be allowed between the back of one bench and the front of another is thirty inches. Leave three feet if possible.

Construction.

There is quite an extensive variety of manual training benches upon the market and an intending purchaser may well feel some indecision in deciding upon a selection. and yet the problem of a selection is not as difficult as might appear from the number to choose from, as the majority, if not all, of the benches offered by the trade are of good construction and well built of good material. The prices quoted by the various dealers are quite uniform for similar grades. The benches offered are usually constructed throughout of selected maple and the tops are always of this material. Some makers use other woods for the parts other than the tops—ash or a soft wood. In one or two instances iron or steel is made use of for the legs.

The various benches may be classified in general as follows:

Single, double or quadruple.

With or without cabinets or drawers.

With one or with two vises.

With wooden or metal vises.

With or without tool-racks.

Adjustable to various heights or non-adjustable.

Draw-bolt or keyed mortise and tenon.

Most dealers do not list double or quadruple benches. The advantages claimed for them are economy of space, and a slight saving in initial cost. The saving in either case is more than counterbalanced by their disadvantage as compared with the single bench. Therefore the single bench is the only one here considered.

The addition of cabinets or drawers adds materially to the cost of the bench and, as a rule, will be found unnecessary.

A bench fitted with two vises is to be preferred as there are operations in wood-working when the end vise proves of material assistance. The additional vise is not essential, though desirable, and should be dispensed with only on the score of economy either of space or money. If wooden vises are employed the additional cost is only two dollars.

Benches are fitted with either wooden or iron vises. Each kind possesses certain advantages. The wooden vise is considerably cheaper. The iron vises are usually of the quick adjustment variety, that is, a quarter turn of the handle to the left permits of the setting of the jaws at any required opening and a return quarter-turn clamps the work in place. The iron vises range in price from three to seven dollars. One or two forms have a maple facing to protect the tools. Some of the end vises have a dog that may be projected above the flush surface of the vise, and is used to clamp work securely in place against one of a row of pegs in the top of the bench.

Benches are built with or without a tool rack extending above the top of the bench at the back. In the latter

case provision is sometimes made for the tools in a drawer or cabinet constructed as a part of the bench. The objection to the use of the drawer is the tendency to throw the tools in a heap, and also the littered condition that a drawer is apt to assume. The tools are more liable to being dulled or nicked than when placed on a rack. The

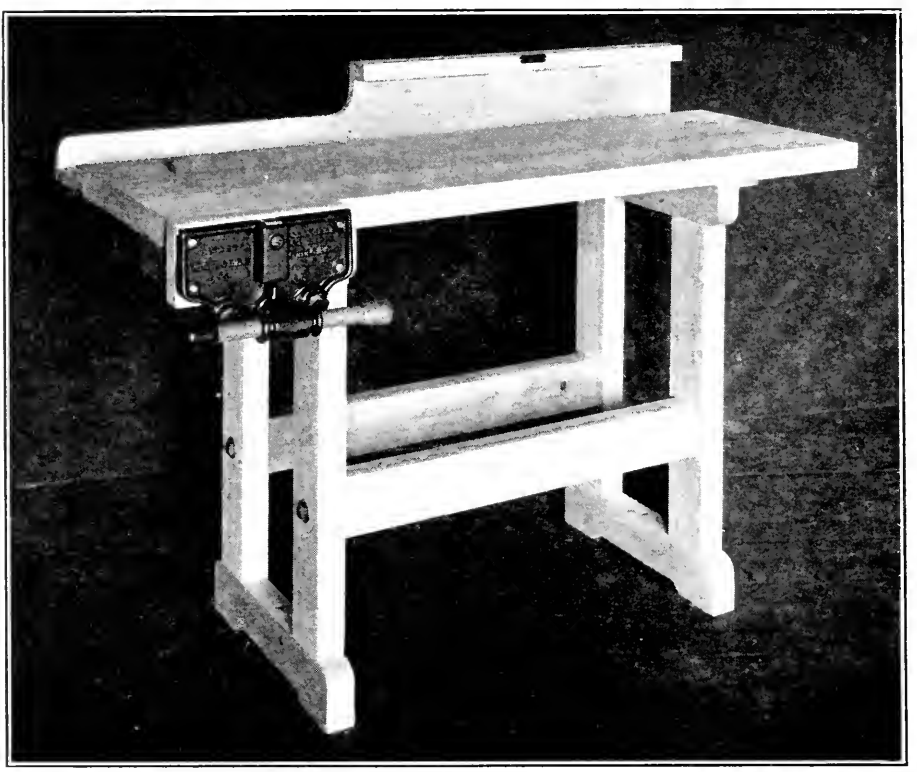


Fig. 19 Wood Working Bench. Draw Bolt Construction.

rack has the disadvantage of shutting off some of the light, especially when light is not over-plentiful, and also of the preventing of the free swing of work above the top of the bench. It has the advantage of having a place

for each tool, having each tool within reach, and on account of its conspicuousness the teacher is enabled to take a hasty inventory of the entire equipment, noting that each tool is in its proper place, in proper condition, and that the equipment is complete. A good plan is to have the racks flush with the surface of the bench with only the handles of the tools protruding. (See Fig 23.) One form of bench has a portion of the top recessed at the back for a width of about seven inches. This affords a place for the tools when in use and prevents their being shoved off the bench.

Some benches are made adjustable to heights of from 28″ to 32,″ by blocks inserted between the tops and the frame. Where such provision is not made the end may be attained by trigging up with blocks under the legs. A small platform about two or three inches in height is sometimes made use of instead of lowering a bench. Such an arrangement is sure to be in the way and to be stumbled over.

Rigidity is a prime requisite for a work bench. The carpenter, in building a rough carpenter's bench, makes it rigid by running long boards well down the front and back and by bracing between the legs at the ends with crossed pieces of scantling. The manual training bench derives its rigidity from the use of heavier material and its peculiar construction. All such benches, that are without cabinets or drawers, follow a general type form. There is a top and four legs. The legs are joined in pairs at the top and at the bottom by strips extending from front to rear. These bottom strips are recessed in the centre to form a foot at either end to rest on the floor. The legs are further braced in pairs by two strips at right angles to the first strips and placed somewhat below the

centres of the legs. It is in the method of fastening these strips to the legs that the benches are divided into the two classes of draw-bolt construction and keyed mortise and tenon construction. Specimens of these two forms of construction are shown in Figs. 19 and 20. From the upper surfaces of the strips connecting the tops of the legs dowels extend, fitting into holes in the lower surface of the top of the bench. This arrangement, together with the draw-bolt or keyed mortise and tenon, permits of the bench being knocked down for shipment, and of its being readily set up again.

The working part of the top may be built up of 2½" maple strips glued together. The lumber should be thoroughly seasoned, and all joints glued where practicable. A row of wooden bench-stops is usually supplied.

Mr. Clarence J. Smith, in an article in the *Western School Journal,* dealing with practical suggestions for establishing a manual training department, cites an experience with solid tops for benches that is worthy of consideration:

"Caution: Don't get long carpenter's benches, for they will not serve the purpose. Don't get wide boards or planks from which to construct benches. They will be sure to warp. Get nothing but a bench with a glued-up top. A piece four or five inches wide is wide enough for any piece that goes into the construction of the top. I know of some benches procured from the local planing-mill, made from a design of appropriate dimensions, but not specifying glued-up tops. They were equipped with many conveniences, such as drawers and tool-racks, and cost $43 each, yet within a year the foot-wide planks used on the tops had warped so as to render them unfit for service."

Benches range in price from $5.00 to $14.00, depending upon size, and whether fitted with one or two vises, or with wooden or iron vises. Where it is necessary to exercise the greatest economy the home-made, simple carpenter's bench may be installed.

Tool Equipment.

The tool equipment divides itself into two groups: the individual or bench equipment, comprising tools that should be supplied for each bench, and the general equipment, comprising tools used in common. At this point we are considering only the bench equipment; the general tool equipment is dealt with below under the consideration of the "general tool panel" and its equipment.

The following list of tools for the equipment of each bench has been compiled after a careful consideration of the requirements and also of prevailing practice. The prices quoted are net cost per two dozen, or $6.04 for the cost of a single bench equipment.

Rule, 2-foot, 2-fold,	$1.98
Sloyd knife, blade 2½ inches,	8.10
Marking gauge, Stanley's No. 65,	4.64
Try-square, 6 inch,	4.24
Firmer chisel, ¼ inch,	3.98
" " ⅞ "	6.30
Rip saw, 8 points,	23.76
Back saw, 10 points,	19.88
Jack plane, Bailey's No. 5,	36.72
Block plane, Stanley's No. 16,	16.20
Spoke-shave, Stanley's No. 64,	1.72
Bench-hook, wood,	3.60
" -brush,	4.24
Drawing kit, Bradley's No. 102,	9.60
Total cost for bench tools,	$144.96

By adding the cost of bench tools, $144.96, to the cost of general tools, $112.85, the total cost for all the tools amounts to $257.81. Allowing $10.00 for the cost

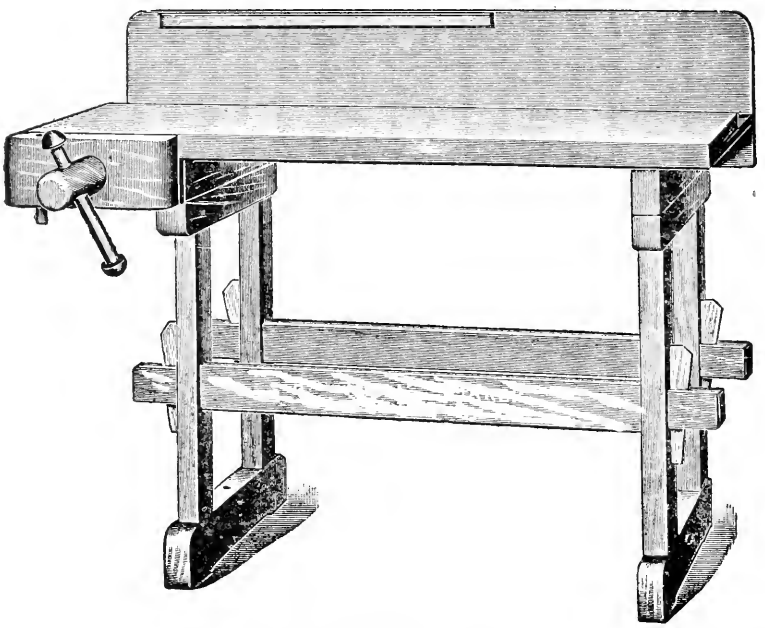


Fig 20. Wood Working Bench
Keyed Mortise and Tenon

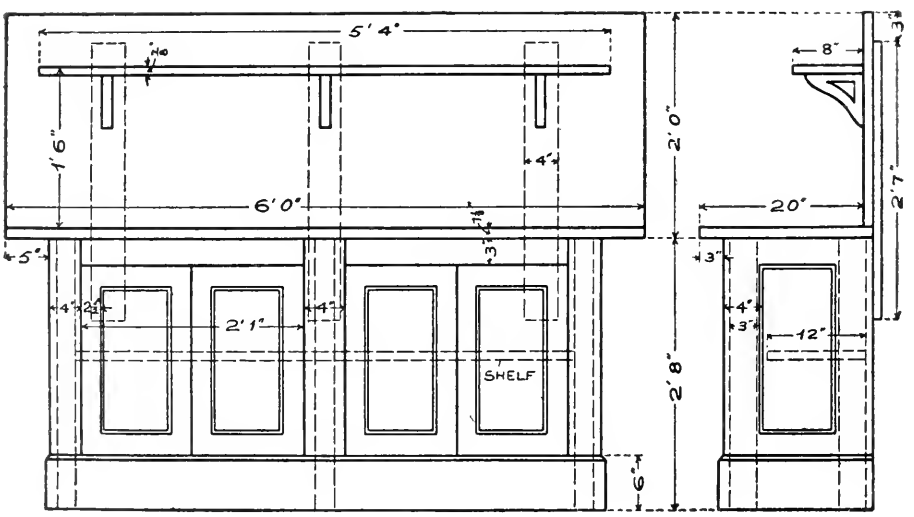


Fig. 21. Glue and Stain Bench,

of each bench, the total cost for bench and tool equipment for a class of twenty-four pupils, as per above specifications, amounts to $497.81, or in round numbers, $500.00.

A grindstone at, say $9.00, should be included in the list of necessary tools.

By installing the cheaper grade of benches and curtailing the general tool equipment, the total cost may be reduced to $350.00, or even less.

On account of their suggestiveness, the following sample equipments are here inserted.

School equipment for twenty-four pupils and teacher, prepared by Mr. E. L. Valentine, of Chicago. The approximate price for this equipment is $550.00:

25 No. 5 Bailey Iron Jack Plane,
25 No. 2 Bailey Iron Smoothing Plane.
25 Whittling Knives.
25 No. 61 Boxwood Rules.
25 10-inch Back Saws.
25 1-inch Socket Firmer Chisels.
25 Bristle Counter Brushes.
25 Bench Hooks.
25 7/8-inch Gouges.
25 Drawing Boards, 12x18-inch.
25 T Squares.
25 45° Triangles.
25 Eagle Pencil Compasses.
25 Emery Oil Stones 3/4x1 5/8x-6 inch.
25 No. 20 Try Squares, 7 1/2-inch.
25 Erasers, 5/8x4-inch.
13 No. 62 Stanley Marking Gauges.
13 1/4-inch Socket Firmer Chisels.
13 Champion Screw Drivers, 4-inch.
13 Wing Dividers, 6-inch.
13 12 Bell Faced Claw Hammers.
13 Rip Saws 8 pts. 22-inch.
13 Cross Cut Saws 10 pts., 20-inch.

General Equipment.

12 Double Benches.
1 Teacher's Bench.
1 Langdon Mitre Box.
1 12-inch Monkey Wrench.
1 Pair 5-inch Cutting Pliers.
1 14-inch Compass Saw.
1 Drawing Knife, 8-inch.
1 Saw Vise.
1 Saw Set.
1 Set 3-16 inch Steel Figures.
3 1/2-inch No. 8 Buck Bros.' Tang Firmer Gouges.
3 1/4-inch No. 8 Buck Bros.' Tang Firmer Gouges.
12 No. 12 Bliss Hand Screws.
12 No. 6 Bliss Hand Screws.
6 6-inch Colt, Eccentric Clamps.
6 12-inch Colt, Eccentric Clamps.

1 Set ½-inch Steel Letters.
1 Set Auger Bits.
1 Set Dowel Bits.
1 Grind Stone with frame complete.
1 26-inch Rip Saw.
2 Rose Countersinks.
2 Screw Driver Bits.
1 Countersink.
1 Expansive Bit, large, ⅞ to 3-inch.
1 10-inch Ratchet Brace.
3 Plain 8-inch Braces.
3 Washita Gouge Slips.
12 Assorted Carvers' Punches.
12 Chip Carving Knives.
6 Knurled Nail Sets—Cup Point.
3 Cabinet Scrapers.
3 14-inch Turning Saws.
3 12-inch Turning Saws.
6 24-inch Colt, Eccentric Clamps.
2 48-inch Colt, Eccentric Clamps.
3 Saw Files, 5-inch with Handle.
1 Rat Tail File, 6-inch with Handle.
12 Assorted Wood Files.
6 Varnish Cups.
6 Varnish Brushes.
1 Gross No. 3 Lead Pencils.
3 Dozen Carpenter Pencils.
12 No. 100 Coping Saws.
3 Rubber Mallets.
1 6-inch T Bevel.
2 6-inch T Bevel.
1 Automatic Hand Drill, with 8 Drills.
3 ½-inch Socket Chisels.
3 ⅛-inch Socket Chisels.

The following individual bench equipment was supplied to the Bradley Polytechnic Institute. Approximate cost, $10.00:

1 No. 5 Bailey Iron Jack Plane.
1 No. 16 Bailey Iron Block Plane.
1 No. 1 Bench Rule.
1 Pair Winding Sticks.
1 10-inch Back Saw.
1 Bit Brace.
1 7-oz. Bell Face Claw Hammer.
1 2½-inch Mallet.
1 No. 64½ Stanley Marking Gauge.
1 6-inch Try Square.
1 9-inch Eagle T. Bevel.
1 No. 6 Sloyd Knife.
1 Round Point Nail Set.
1 Screw Driver, 4-inch Blade.
1 ¼-inch Chisel.
1 1-inch Chisel.
1 ½-inch Dowel Bit.
1 5-16-inch Dowel Bit.
1 Bench Brush.
1 2½-inch Wood Spoke Shave
1 Sharpening Outfit, consists of 1 Oil Can, 1 Oil Stone, 1 Waste Cup.

The wood-working equipment for the three last years of the grammar grades in the Boston Schools is as follows:

30 benches,
30 rip saws,
15 cross-cut saws,
30 back saws,
30 ¼-in. chisels,
30 ½-in. chisels,
30 1-in. chisels,
30 spoke-shaves,

30 jointer planes,
30 jack planes,
30 smooth planes,
30 block planes,
30 bit-braces,
30 screw drivers,
30 nail sets,
30 hammers,
30 half-round files,
30 flat files,
30 mallets,
30 rules,
30 gauges,
30 try-squares,
30 bevels,
30 compass-attachments,
30 bench brushes,
30 bench hooks,
30 sloyd knives,
12 veining-tools,
12 skew-chisels,
24 carving gouges,
12 turning saws,
15 ¼-in. auger-bits,
15 ⅜-in. auger-bits,
15 ½-in. auger-bits,
15 ¾-in. auger-bits,
1 automatic borer,
12 German bits,
12 drill bits,
15 centre bits,
6 countersinks,
1 Bailey combination plane,
6 mortise gauges,
1 keyhole saw,
1 framing square,
6 cabinet scrapers,
6 file cards,
1 burnisher,
6 hand screws,
2 oil-stones,
1 set carving oil-slips,
1 oil can,
1 knife file,
1 hatchet,
30 stools.

The following description of the equipment of the wood-working department of the Mechanic Arts High School, Boston, Mass.,* is replete with suggestions. An equipment installed at the present time would probably specify single benches in place of the double ones, and might also limit the number of benches to 24, experience having shown that this number is the maximum for efficient instruction.

"Two adjoining rooms on the second floor are assigned to the department of wood-working with hand tools. This department is equipped to accommodate daily six classes of thirty-six pupils. Each room is furnished with eighteen double benches, 57 in. long, 45 in. wide on the top, and varying in height from 29 to 33 in. On each side of these benches is a tier of three drawers, one of which is assigned to each pupil, for the set of cutting tools

*Annual Report of the committee on Manual Training 1901, Boston, Schoo Document No. 4.

with which he is supplied. Here, also, are kept his apron and unfinished work. Upon a vertical tool board 9½ in. high which divides the top of the bench in the centre, and upon hooks and shelves at the ends of the bench, are kept the following measuring and miscellaneous tools used in common by members of different classes:

Stanley Rule and Level Co.'s tools: one each, T. bevel, 10-in., No. 18; rule, 2 ft., No. 18; try-square, 6 in., No. 10. A Buck Brothers screw-driver, 5 in., No. 69; Bemis & Call wing dividers, 7 in.; a Spofford bit-brace, No. 108; a Disston rip-saw, 22 in., D 8, with 8 teeth to the inch; a Disston cross-cut saw, 22 in., D 8, with 10 teeth to the inch; a Disston back-saw, 12 in., No. 4; a Bliss mallet, No. 3; a Maydole adze-eye bell-faced hammer, No. 13; a Washita oil stone, 8 by 2 by 1⅛ in. in box; a brass paragon oil can, No. 0; a bench hook, 12 by 8 by ⅞ in.; two winding sticks, 18 by 2 by ½ in.; a dust brush.

"The individual sets kept in the drawers are:

Bailey's patent adjustable iron tools; one each, jack-plane, 14 in., No. 5; jointer-plane, 22 in., No. 7; smoothing-plane, 8 in., No. 3; spoke-shave, No. 51; Buck Brothers shank firmer chisels, No. 2, one each, ¼, ⅜, 1, 1½ ins.; a gothic point knife; genuine Russell Jennings bits, one each, ¼, ⅜, ½, ⅝, ¾ in.; a whisk broom; a Stanley marking gauge, No. 65.

"Each pupil is also supplied with a tray 26½ in. long, 13¾ in. wide, and 1¾ in. deep, divided into compartments adapted to receive the following set of Buck Brothers London style carving tools:

Chisels, one each, 1 in., No. 1; ½ in. No. 1; ⅜ in. No. 2; gouges, one each, ⅝ in., No. 3; 3-16 in., No. 4; 3-32 in., No. 5; 5-16 in., No. 5; 7-16 in., No. 5; ⅝ in., No. 5; ¼ in., No. 6; 3-16 in., No. 7; 5-16 in., No. 7; 1-32 in., No. 11; ⅛ in,, No. 11; 5-16 in., No. 11; parting tool, ¼ in., No. 39.

"These trays are stored in cases at one end of each room. Two Brown and Sharpe grindstone troughs, fitted with stones and truing devices, are installed in one of these rooms. Water is brought in brass pipes to all of the grindstones in the various departments, and the troughs are connected with a system of drain pipes which lead to a sand catch-basin in the basement.

"The tool-room, which contains a variety of minor supplies, together with a large collection of miscellaneous tools for occasional use, is located between the two wood-working rooms, and is conveniently entered from either of them. Many of the shelves in this room are divided by narrow strips of wood in such a way that each tool has its appropriate compartment, and it is an invariable rule that every article must be kept in its proper place. Each pupil is supplied with three brass checks bearing his shop number, one of which will be received by the person in charge of the tool-room in exchange for any desired tool. The check is placed in the compartment from which the tool is taken, where it remains until it is redeemed by the return of the tool. The following are the principal tools in this tool-room:

Bailey's patent adjustable iron planes: 4 beading, No. 50; 2 dado, fillester, plow, etc., No. 46; 1 tonguing and grooving, No. 48; 1 tonguing and grooving, No. 49; 24 rabbet, 1 in., No. 192; 1 beading, rabbet, and slitting, No. 45; 1 bull-nose rabbet, No. 75; 2 circular, No. 13. Buck Brothers' tools; shank firmer chisels, No. 2, 6 each, ⅛ in., 3-16 in., 5-16 in., ½ in., ⅝ in., ¾ in., ⅞ in., 1⅛ in., 1¼ in.; 12 each, rose counter sinks, No. 83, snail counter sinks, No. 84; 6 cabinet makers' burnishers, 5 in., No. 91; 18 square-point nail sets, assorted; 18 round-point nail sets, assorted. One new Langdon mitre box, No. 2; 1 Stanley adjustable spirit level, 30 in.; 2 adjustable ball and socket saw clamps; 1 rachet bit brace; 6 Stanley rule trammel points, No. 99; 2 Morrill saw sets, No. 1; 2 Stubs flat nose pliers; steel figures and letters for wood, 1 set ¼ in.; for metal, 1 set ¼ in. and 1 set ⅛ in.; 72 chalk lines, reels, and awls; 24 brad awls, assorted sizes; 2 Clark patent expansive bits; 3 Sargent steel squares, 24 in., No. 300. Files: 36 flat bastard, 10 in.; 30 half round bastard, 10 in.; 12 half round smooth, 10 in.; 6 pillar, 7 in. by ½ in., No. 6; 12 three square, 7 in., assorted; 6 Nicholson file brushes. Stanley Rule and Level Co.'s tools: 2 try-squares, 12-in., No. 10; 2 mitre squares, 12 in., No. 16; 12 Bemis & Call wing calipers, 6 in.; 12 best French cabinet scrapers, square, 5 in. by 3 in.; 12 best French Cabinet scrapers, curved, 5½ in. by 2½ in.; 1 Coes monkey wrench, 12 in.; 60 Miller's Falls turning saws and frames, 18 in.; genuine Russell Jennings bits, 12 1 in., one each, 5-16 in., 7-16 in., 9-16 in., 11-16 in., 13-16 in., 15-16 in.; German nail bits, 12 each, ⅛ in., 5-32 in., 3-16 in.; 6 Stearns patent dowel pointers; 2 Disston rip-saws,

26 in., D 8, 6 teeth to the inch; 2 Disston cross-cut saws, 26 in., D 8, 7 teeth to the inch. R. Bliss & Co.'s tools: 18 cabinet makers' clamps, No. 74; 60 hand screws, No. 11; 60 hand screws, No. 4. Buck Brothers' London style carving tools, four of each: front bent chisels, No. 21, 1-16 in.; No. 21, 3-16 in.; No. 21 ½ in.; No. 22, ⅛ in.; No. 22, 5-16 in.; No. 22, ½ in.; No. 23, ⅛ in.; No. 23, 5-16 in.; No. 23, ½ in.; front bent gouges, No. 27, ⅜ in.; No. 32, ¼ in.; back bent gouges, No. 35, ¼ in.; No. 38, ¼ in.; parting tools, No. 43, ¼ in.; gouges, No. 3, 1 in.; No. 5, 1 in.; No. 11, ⅝ in.

"Opening out of one of the wood-working rooms is a small room for the preparation of stock for models and for special saw work. Here are installed a Colburn double-arbor bench saw, and a Dover band saw for the use of the instructors and especially skilful pupils only, and a Mosely jig-saw which all the pupils are taught to use. The location of these saws in a separate room permits their use without disturbance to class exercises. An adjoining room is furnished with convenient tables and other fixtures for the final work upon all models or projects which require shellac or other painter's finish."

While it is desirable that all work be done under the best conditions and with an ample and adequate equipment, the lack of sufficient funds to install an up-to-date equipment need not deter the earnest teacher from making a start in introducing bench work. As a possible encouragement to such a teacher the following quotation from the twenty-first annual report of the School District No. 3, Sterling, Illinois, is here inserted as showing what can be done under somewhat adverse conditions, backed by determination and initiative:

"The tables which had done duty in the science room of the old Sterling High School made excellent work benches.

"Throughout the year the seventh and eighth grades of both schools have had regular instruction, one hour

per week. Forty boys and thirty-four girls have taken the course. The initial expense in setting these pupils to work, including eight dozen sloyd knives, four dozen try-squares, four dozen coping saws, one rip-saw, two mitre-boxes and whitewood lumber was $46.78. The additional expense to carry the work through the year was about $38.00, making the total expense about $84.78.

"In May of this year, the girls of the two schools gave a 'Girls' Program' as a sequel to the 'Boys' Program,' which netted $28.45, and this was followed by a 'Primary Program,' which netted $26.50, both of which amounts were turned over to the treasurer of the fund. We have thus raised for manual training purposes by public exercises $103.14, of which $84.78 has been expended. This expense does not include $15.00 which the Board has paid for one dozen vises, nor the lumber for a dozen work benches.

"Of this material which the Board purchased for work benches, the boys of Lincoln School have made, out of school hours, five benches, and enough material is on hand for seven more benches. The boys made these benches entirely themselves and they would be pleased to have the Board test the 'plumbness' and 'squareness' with which they stand in the world and their fitness to meet a young workman's needs.

"I very much regret that at the present writing I have not access to all the bills above mentioned, but I am safe in saying that the total expense of conducting our first year's work in manual training was less than $110.00, and the greater portion of this amount is in tools and benches, and thus available for future work."

One other report from the field of an actual experience in the question of cost and maintenance may prove

helpful. The following quotation is from the thirty-fourth annual report of the Public Schools of Columbus, Ga.:

"The original equipment of twelve benches with the necessary tools was $166.00. This included for each bench, 1 jack plane, 1 smooth plane, 1 block plane, 1 1-inch chisel, 1 2-foot rule, 1 sty square, 1 marking gauge, 1 back saw. Also for general use 1 rip and 1 cross-cut saw, brace and bit, screw-drivers, nail sets, etc., 6 hammers, 6 ½-inch chisels. During this year additional tools to the amount of $30.00 have been purchased. These include rip and cross-cut saws, 2 of each; 6 skew chisels, 6 mallets, 6 bench brushes, 30 pencil compasses, a rachet brace, building square, two turning saws, 12 ½-inch chisels, 12 ¼-inch chisels, 6 files, 2 gouges, 1 grindstone. The supplies for consumption, including lumber, hardware, sandpaper, glue, etc., have cost about $140.00, which for 140 boys, the average number, amounts to $1.00 a pupil."

Demonstration Space.

It is customary, in a well-equipped shop, to reserve a portion of the room for demonstration purposes. If the available space will not permit of this reservation it may be dispensed with. The equipment consists of seats or benches for the number of pupils in the class, a work bench and complement of tools for the teacher, and a blackboard. Simple wooden benches, with backs, will suffice for the seating of the class. They should be arranged on a raised platform of two or three tiers to afford each pupil an unobstructed view of the demonstration work.

The entire demonstration outfit, exclusive of the teacher's work bench and tools, can be supplied at from $40 to $80.

The demonstration theatre in one of the shops at the Mechanic Arts High School in Boston, is shown in Fig 38.

Glue and Stain Bench.

At the left in Fig 23 is shown a glue and stain bench. A working drawing of a somewhat similar bench is

shown in Fig 21. It contains lockers for the storage of materials. The lockers may be dispensed with, in which case the materials in use may be placed on the shelf and the stock that is kept on hand can be stored in the storage room. The equipment consists of a glue pot and means for heating it. An ordinary gas stove, at 25 cents, will serve for heating purposes. Where gas is not available a kerosene glue heater may be substituted, costing for a one-pint pot, $1.00 or for one-quart pot, $1.50. A one-quart porcelain enameled glue pot retails for 53 cents. A two-quart steam glue heater, fitted with pipe for steam, overflow pipe. brass bib-cock for drawing water from tank, and stand can be had for $7.00. There is not sufficient use for glue in ordinary school work to justify the

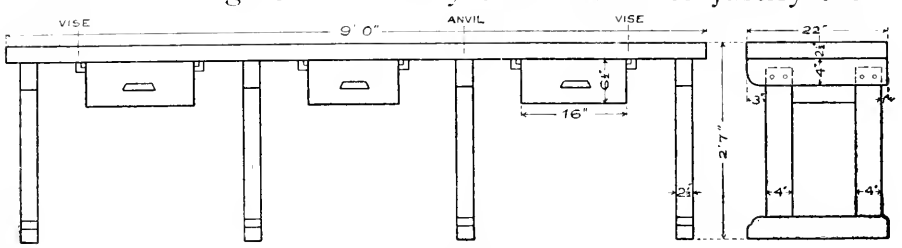


Fig 22. Metal Working Bench.

installation of the steam glue heater. Besides the clamps listed in the general tool list a number of large cabinet clamps should be provided if large projects are a part of the course. A glue and stain bench may cost about $35.00.

Metal Working Bench.

There is more or less simple metal-work introduced in connection with the constructive wood-work. A strong bench equipped with a machinist's vise will meet the requirement. The form of vise having an anvil cast with it will be found serviceable. The bench can be installed for $15.00. A metal-working bench, with tools, is shown

to the left of the general tool panel in Fig. 23. A working drawing of such a bench is shown in Fig. 22.

Display Panels.

The wall space about the room may advantageously serve for panels for the display of specimen woods, cones and leaves, a typical course in bench-work, and for general tools.

General Tools.

A compactly arranged panel of general tools may be conveniently placed with relation to the work benches. Such a panel is illustrated in Fig 23.

The attempt has been made to arrange the following list of general tools in the order of their importance and desirability, so that, when necessary, curtailment may be made with least danger of impairing the efficiency of the equipment:

12	cross-cut saws, 10 points,	$ 10.59
12	hammers,	4.46
12	bit braces, 6″ or 7″ sweep,	9.51
12	auger bits, ¼″,	1.98
12	" " ½″,	3.16
6	" " ⅝″,	1.85
6	" " ¾″,	2.16
6	" " 1″,	2.82
3	centre " 1¼″,	.52
6	drill " 3-16″,	.52
3	" " 7-32″,	.65
6	countersinks, ½″,	.57
12	screwdrivers,	2.43
4	brad awls, 1″,	.13
8	" " 1¼″,	.25
12	carver's skew chisels, ½″,	3.15
12	" veining tools, 1-32″,	3.87
8	turning saws, 14″ x ⅛″,	6.88
24	compasses (with pencil attached),	2.98
12	hand screws, or iron clamps,	3.60
12	Firmer chisels, ½″,	2.42
6	" gouges, ⅞″,	1.66
6	" " 1″,	1.96
4	" " ¾″, (inside bevel),	1.27

4 10″ iron bevels,	1.91
4 oil-stones, 2″ x 8″ mounted,	2.85
4 brass oil-cans, No. 1,	.65
2 Washita oil-stone slips,	.28
1 set of carving tool slips,	.61
6 smooth planes, Bailey's No. 4,	15.88
6 cabinet scrapers (one end round),	.25
2 mortise gauges, rosewood, Stanley's No. 77,	.78
8 sets of winding sticks,	
1 rabbet plane,	.79
1 10″ try-square,	.34
2 burnishers,	.61
2 key-hole saws, iron handle,	.21
6 wing dividers, No. 5	.75
12 nail-sets (hollow points), knurled,	.90

Fig. 23. View in Wood Working Shop, showing General Tool Panel, Metal Working Bench and Stain Bench.

12 hand bastard files, octagon handles,	2.08
6 " " " half-round,	1.30
3 file cards,	.46
8 mallets,	.56

1 pair cutting pliers,	.61
2 cabinet clamps, Bliss' No. 73,	1.23
8 Firmer chisels, 3-16 inch,	1.22
2 joiner planes, Bailey's No. 7,	4.47
1 expansion bit,	.72
1 mitre-box, Langdon's No. 18,	6.30
1 hatchet,	.58
1 7-inch drawshave,	.47
1 pair calipers, 6-inch wing,	.26
1 matching-plane,	1.53
1 plow, Stanley's No. 45	4.86
In addition:	
1 grindstone, complete,	12.65
1 glue-pot outfit,	4.00
Total cost of full general tool outfit,	$129.50

There are two or three large general tools that form a group by themselves in that each of them may be driven by power. The first of these is the grindstone. The stones are supplied in numerous diameters, and of varying widths of face. A stone for school purposes should be at least 18 inches in diameter and have a face of 2¼ inches in width. A stone of this size, mounted on a hardwood frame, with treadle and handle sells for about $5.00. A 30 x 4 inch stone, mounted on an iron frame, with adjustable tool rest, truing attachment, water pot, and pulley for power, lists at $24.00. The same combination without truing attachment, but arranged for hand and foot power, is quoted at $20.00.

A hand and foot power circular saw, with 7-inch saw—both rip and cross-cut—weighing complete about 330 lbs., and suitable for most purposes for which a circular saw is required in a school-shop, may be had for $60.00. A first class power saw suited to meet all shop requirements costs about $175.00.

A foot-power band saw, capable of cutting a 40-inch circle, having a table 22 x 22 inches, and weighing 350

lbs., costs $65. A similar power saw costs about the same.

A power planer is a desirable but not a strictly necessary addition to the equipment.

Specimen Woods.

A desirable adjunct to a wood-working room is a display of the woods in general use in constructive work. Such a display is distinctly educational, and also has an

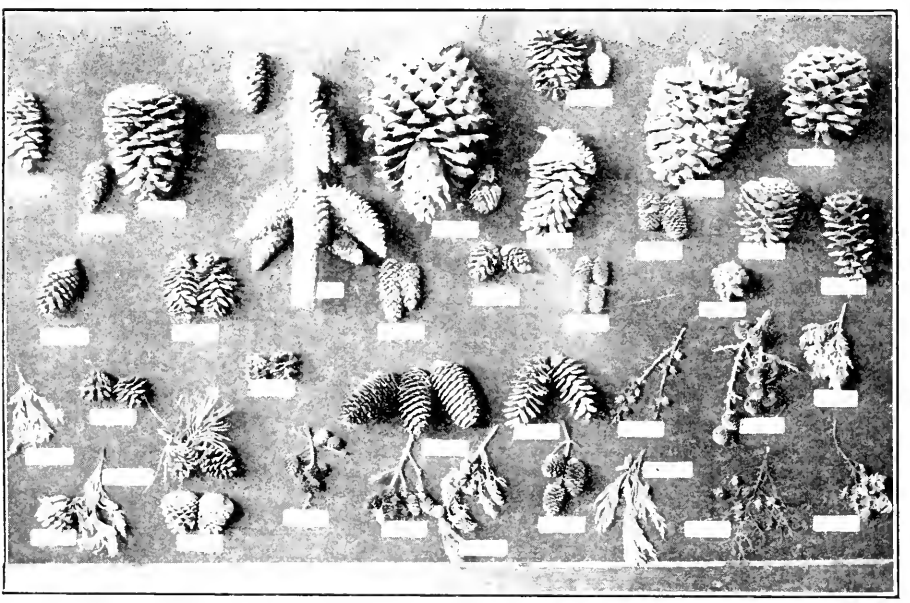


Fig. 24. A Panel of the Cones of the Evergreens.

appropriate decorative value. Various methods of preparing the specimens suggest themselves. The woods may be cut into small slabs of about 4″ x 10″ x ½″. One half may be varnished to show the relative effect of the natural and finished wood. A small eyelet in the top will permit of hanging the specimen in place, and of its ready inspection. If the panel is covered with some dark material, as green baize, the woods will be thrown in relief. Long panels,

holding single rows of specimens, may be effectively distributed on otherwise unutilized wall spaces.

Specimen Cones, Etc.

The same motives prompting the display of specimen woods would suggest a display of the cones of the various evergreens, their needles, etc., and also of pressed leaves of the hard woods. Fig. 24 shows a panel arranged to illustrate the softwood series of cones.

Typical Course.

A part of the upper wall space might be used for a display-panel of a typical class course. Such a display would be found of use in giving a visitor an insight into the kind of work pursued by the class.

Bulletin.

A plain panel of soft wood, or of cork-mat, placed near the entrance door, may serve as a bulletin board.

Storage.

Lumber should be stored, if possible in a separate room, as suggested above under the caption "storage-room."

Finished Work.

Finished work, which it is desired to keep at the school, may also be stored in the pigeon-holes provided in the regular storage-room, or in similar pigeon-holes in the teacher's room.

Work in Process of Construction.

For the storage of partly finished work, each student should be supplied with a separate pigeon-hole in a cabinet. The size of these pigeon-holes is largely determined by the size of the work constructed. This does not apply to large special pieces as a chair or desk, which must be stored as best they may be in any available space. The number of pigeon-holes to be provided is dependent upon the number of classes using the room during any one

school term and the number of pupils in each class. In Fig. 25 is shown a drawing of a cabinet designed to accommodate three classes of 24 pupils each. It will be

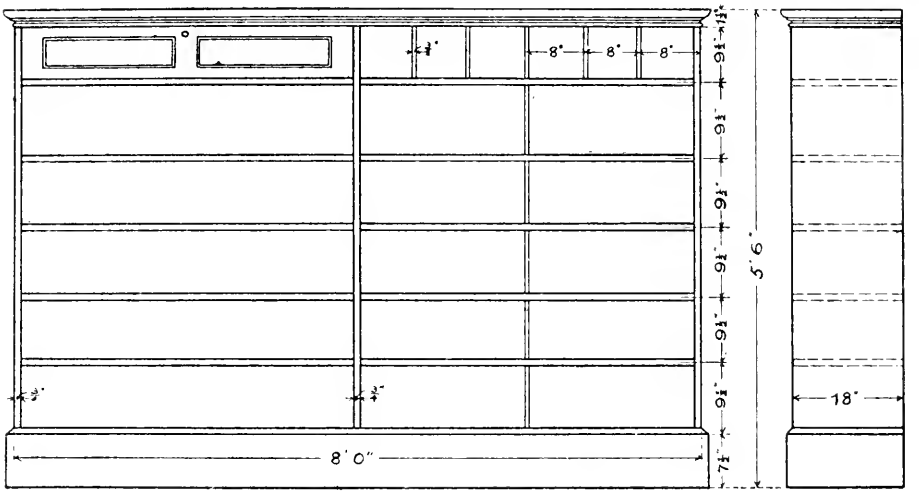


Fig. 25. Lockers for Wood Working Room.

noticed that the pigeon-holes are arranged in groups of six, each group having a separate lid. The dimensions given for the pigeon-holes have been found to meet the requirements.

Nails and Screws.

To accommodate the numerous sizes of nails and screws required a separate cabinet of small drawers may be provided.

Blue Prints.

If blue-prints are used, a cabinet composed of pigeon-holes, each hole being a trifle higher and deeper than the size of the blue-print and wide enough to hold all the prints of one kind, will be found convenient. Or a similar provision might be made by having the prints lie flat. Some of the large pigeon-holes in the storage-room or the teacher's room might be subdivided to meet the requirement.

The blue-print may well be dispensed with altogether, and in lieu, the student may work from his own drawing, or from the blackboard drawing made by the teacher as a part of his demonstration.

Decorations.

Before leaving the question of the furnishing of the room it may not be out of place to add a suggestion or two regarding the further decoration of the room, and for devices to add to the broader appreciation of the work. The panels of specimen woods, cones, etc., form a distinctively decorative feature which may be further enhanced by photographs of lumbering industries, forest scenes and allied subjects. A set of prints of the principal lumber-furnishing trees, with enlarged detailed views of their leaves and bark, is a well-known publication. These prints, framed, are an effective addition to the room. A table, with a book and magazine rack, supplied with a few books on wood-working and some papers or magazines containing working-drawings of simple objects, is also suggested as a device to broaden the interest of the pupil in his shop-work. There are a few books on wood-working that make a direct appeal to boy nature and also one or two periodicals that emphasize constructive wood-work for boys in a way that is very real to the boy. The wise teacher knows the value of the use of these adjuncts to his work; knows the influence of sympathetic mutual interest in the wider outlook upon the work at hand. Therefore a suggestion of an equipment that may aid in bringing a pupil more closely in touch with the significance and bearing of his work may be germane.

Touching upon this question of room decoration, Mr. Albert H. Leake, Inspector of Technical Education, Ontario, says:*

*"Manual Training in Canada"—Manual Training Magazine, April, 1904.

"In the vast majority of cases the centres are almost ideal in character, and in one or two instances where rather unsuitable rooms were the only ones available, no expense was spared to make them efficient. In many places outside of Canada but little attention is paid to the general appearance of the manual-training room, and the typical room has been as unlovely and barn-like a place as it could be made. Here we have proceeded on somewhat different lines. We believe, and believe strongly, that the influence of the place in which a boy works leaves its impress on both the character of the boy and the quality of his work, and in conformity with this idea we have sought to make our rooms bright and attractive, devoting special attention to their decoration, though everything that has not a direct bearing on the work has been rigidly excluded. Specimens of timber, sections of trees, examples of work, and photographs have been liberally supplied. The actual course of models being taken is displayed by means of large drawings around the room. These are very effectively and economically prepared with white chalk on ordinary wall-paper. Every kind of tool in use has been taken apart, and the separated parts mounted and properly named. It is surprising what an effect illustrations of this kind have in stimulating a healthy curiosity in the minds of the boys."

Maintenance.

The cost of maintenance is largely dependent upon the cost of lumber. There are other items, as hardware and the replacing of worn out or broken tools, but the chief item is that of stock. The kind of stock used, as well as its cost, varies greatly in different sections of the country, and as the reader may readily obtain the price of lumber in the local market,

any attempt to quote prices here for different localities would be of but secondary help. In the vicinity of New York white pine and white wood are most frequently used. Gum-wood, bass-wood and cypress are also used to less extent. It is desirable that all lumber used should be of good quality and free from knots. The lumber should be planed at the mill, and also cut-up into sizes for class use if there is no provision at the school for doing the work.

A considerable item in the cost of maintenance of all shop work is the depreciation of tools, benches, and other fixtures through loss and wear.

A study of one equipment over a period of ten years and another over six years would seem to indicate that 10 per cent. is a conservative estimate of this factor. In many cases the loss would undoubtedly fall below this proportion.

In an endeavor to ascertain the cost per pupil for materials used in the bench work, the following table has been compiled. It will be noticed that there exists a very wide range in the costs given: from 21 cents in Los Angeles to $2.35 in Chicago. The work is that of the seventh and eighth grades:

	No. of Pupils.	*Cost per Pupil.*
Cleveland, O.	900	.25
Toledo, O.	1095	.68
Springfield, Ill.	225	1.40
Chicago, Ill.	4231	2.35
Minneapolis, Minn.	1108	.40
Carthage, Mo.	60	.25
Los Angeles, Cal.	2005	.21
Columbus, Ga.	200	.30
Hampton N. & A. Inst.	24	.33
Homestead, Pa.	120	.40
Baltimore Polytechnic Institute	279	.41
Carlstadt, N. J.	35	1.00
Montclair, N. J.	80	.30
Newark, N. J.	975	.33
Red Bank, N. J.	90	.25
Concord, Mass.		1.00

Berkeley School, N. Y.	31	1.35
Milton, Mass.	85	.45
Natick, Mass.	60	1.00
Lewiston, Me.	138	.70

Average cost per pupil, $0.67.

The following detailed list of work-shop supplies will be found valuable as a reference list. The items and prices are selected from a school supply list. The prices quoted are wholesale and can be obtained only when large orders are given. This accounts for the discrepancy between these prices and the prices given for similar items above. The above prices are retail for small quantities and are always subject to discount for large orders:

Awls, Scratch Awl, 2½ in., forged blade, maplewood handle, each	.03¾
Benches, as per Specifications and Drawings, each	30.90
Bits, Cast Steel, Bright, Center.	
3-16 in., each	.04
¼ in., each	.05
⅜ in., each	.05
½ in., each	.06
⅝ in., each	.07
Bits, expansive (Small), boring from ⅝ in. to 1¾ in., each	.51
Bits, Gimlet, 2-32 in., 4-32 in., 6-32 in., 8-32 in., each	.05
Bits, Screwdriver, each	.05
4-16 in., each	.09½
6-16 in., each	.10½
8-16 in., each	.11½
10-16 in., each	.12½
Blades, for Fret Saws, No. 3, per doz.	.05½
Blades, for Hack Saws, No. 8, per doz.	.34
Boxes, Mitre, for molding, 2½ to 4 inches, each	1.14
Braces, 6 in. sweep, ball-bearing, each	.33
Brushes, Varnish, 1½ in. flat, each	.04½
Butts, Brass, 1 in., middle, per doz.	.06
Chisels, 5½ in. from bolster to point, best quality, handled with applewood handles and sharpened:	
1 in., each	.21½
½ in., each	.17½
¼ in., each	.13½
Cloth, Emery, Nos. 00 to 1½, per ream	7.22
Countersinks, rose countersink, case steel, ½ in., each	.08¾
Dividers, winged, 6 in., heavy polished cast-steel joint and set screw, each	.10¾
Dowels, Wood, ¼ in., per 100 feet	.10½
Dowels, Wood, ⅜ in., per 100 feet	.11¾

Dowels, Wood, ½ in., per 100 feet	.13¾
Emery, Nos. 40 to 150, in 10 lb. cans (can included), per can	.55
Files, Flat, bastard, 10 in., each	.10¾
Files, Flat, second cut, 10 in., each	.12½
Files, Half-round, bastard, 10 in., each	.14
Files, Half-round, second cut, 10 in., each	.15½
Files, Round, bastard, 10 in., each	.08¾
Files, 3-square taper, smooth, 6 in., each	.05
Files, for Saw-filing Vises, 12½ in. jaws, each	.05
Gauges, Bit, gauges for bits up to 1 in., each	.15
Gauges, Boxwood, plaited head, brass thumbscrews and shoe, each	.18
Glue, Liquid, Fish, in gallon quantities (can included), per gal.	1.19
Gouges, 5½ in. from bolster to point, best quality, handled with apple wood handles, and sharpened:	
¾ in., each	.24
½ in., each	.21
¼in., each	.18¾
Grinder, Chisel, each	.54½
Hammers, Claw, each	.35
Hammers, Peen, each	.30
Hammers, Tack, Claw, each	.10¼
Handles, Chisel, for tanged chisels, assorted, applewood, brass tube ferrule, per doz	.19½
Hatchets, 4 in., each	.22
Hooks and Eyes, Brass, ¾ in, per doz	.05¾
Knives, Sloyd, 3 in. blade, extra quality, each	.17½
Letters, Steel, ¼ in, set of 27, per set	1.16
Levels, 24 in., cherry, arch top plates, 2 side views, polished, each	.30¾
Locks, per doz	1.43
Mallets, Round, each	.14
Nails, Cut, 4d., per 100 lbs.	2.75
Nails, Cut, 6d., per 100 lbs.	2.65
Nails, Cut, 8d., per 100 lbs.	2.55
Nails, Cut, 10d., per 100 lbs.	2.50
Nails, Wire brads, ½ in., No. 18, per lb.	.07½
Nails, Wire brads, ¾ in., No. 18, per lb.	.06
Nails, Wire brads, 1 in., No. 17, per lb.	.05
Nails, Wire brads, 1¼ in., No. 16, per lb.	.04
Nails, Wire, 1¾ in., No. 12, per lb.	.03¼
Nails, Wire, 1¼ in., No. 13, per lb.	.03½
Nails, Finishing, 1½ in., per lb.	.04
Numbers, Steel, ¼ in., set of 9, per set	.39
Oil, Boiled, in 1 gallon cans (including can), per gal.	.62
Oil, Hard, in 1 gallon cans (including can), per gal.	1.18

Oil, Sperm, best quality, 1 gallon cans (including can), per gal.	.85
Oilers, Brass, 1 pt., each	.16½
Paper, Sand, Nos. 00 to 3, per ream	1.55
Paint (ground), per lb. can:	
Black	.13
Raw Umber	.10
Burnt Umber	.10
Burnt Sienna	.11
Dutch Pink	.15
Chrome Green	.10
Cobalt Blue	.30
Planes, Block, 6 in., iron, nickel-plated, nickel joint, 1¾ in., each	.61
Cutters for above plane, each	.09½
Planes, Combination, No. 45, adjustable, machine, heading, plow and sliding plane, each	4.52
Planes, Fore, iron, adjustable, 18 in., 2⅜ in., each	1.58
Cutters for above plane, each	.12½
Planes, Jack, wood, 15 in., 2 in., each	.81
Cutters for above plane, each	.14
Planes, Smoothing, iron, 8 in., adjustable, 1¾ in., each	1.06
Cutters for above plane each	.13
Plates, Facing, iron planed, 12x12x¾ in., each	3.95
Plyers, 4½ in., flat nose, black, best quality, each	.06½
Plyers, combination cutting and gas, polished, each	.54
Plyers, round nose, each	.06½
Punch, solid, 1-16 in., each	.04
Punch, spring, each	.16½
Rasps, Half-round, medium cut, 10 in., each	.21
Rasps, Half-round, fine cut, 10 in., each	.27
Rulers, Boxwood, 2 ft., 4 fold, arch joint, bound, 8th and 16ths, each	.12
Rulers, Steel, 24 in., graduated, each	.26
Saws, Back, 10 in., for wood, cast steel, blue back, apple-wood handle, polished edges, 3 brass screws, each	.60
Saws, Cross cut, first quality, cast steel blades, beech handle, polished handle, 4 screws, 9 points, 18 inch., each	.61
Saws, Fret, each	.44
Saws, Hack, Star No. 0, each	.59
Saws, Nest of, Pruning, Compass, Keyhole, beech handle, polished edges, per set	.48
Saws, Rip, 20 in., 8 points, first quality, rubbed, cast steel blade, beech handle, polished edges, 4 screws, each	.71
Saws, Sharpening, Back, each	.12
Saws, Sharpening, Cross Cut, each	.23
Saws, Sharpening, Rip, each	.23
Scraper, steel, 3x5 in., each	.03¾

Screw Drivers, 4-in. round blade, ebonized handle, each.... .08¼
Screw Drivers, 10-in. blade, each..... .29
Screw Drivers, 2½-in. blade, each..... .09
Screws, Hand, 10-in. oiled maple, each..... .23¼
Screws, 14-in. oiled maple, each..... .32½
Screws, Wood, flat head, brass, ½-in., No. 3, per gross.... .13
Screws, Round Head, brass, ½-in., No. 2, per gross..... .16½
Screws, Flat Head, Bright:
½ in., No. 3, per gross..... .07¾
¾ in., No. 5, per gross..... .08¾
¾ in., No. 7, per gross..... .09¾
1 in., No. 6, per gross..... .10
1 in., No. 8, per gross..... .11
1¼ in., No. 7, per gross..... .11¾
1¼ in., No. 10, per gross..... .14
1½ in., No. 8, per gross..... .14
1½ in., No. 10, per gross..... .15
1¾ in., No. 10, per gross..... .17
1¾ in., No. 11, per gross..... .18
2 in., No. 9, per gross..... .17½
2 in., No. 11, per gross..... .20
Screw, Round Head, Blued:
½ in., No. 3, per gross..... .09
¾ in., No. 5, per gross..... .10½
¾ in., No. 7, per gross..... .11½
1 in., No. 6, per gross..... .12
1 in., No. 8, per gross..... .13½
1¼ in., No. 7, per gross..... .14
1¼ in., No. 10, per gross..... .16½
1½ in., No. 8, per gross..... .16½
1½ in., No. 10, per gross..... .18
1¾ in., No. 10, per gross..... .20½
1¾ in., No. 11, per gross..... .22
2 in., No. 9, per gross..... .21¼
2 in., No. 11, per gross..... .24
Sets, Nail, ⅛ in., square, polished, round point, each..... .05
Sets, Saw, for hand saws, each..... .26
Squares, Try, 6-in., nickel-plated, iron stock, graduated steel blade, square inside and outside, each..... .14¾
Squares, Try, 15-in., rosewood, brass-faced, graduated, tempered steel blade, each..... .33½
Spoke Shave, 6-in. blade, each..... .10¼
Stones, Grind, 24-in., iron frame, with treadle, steel arbor, babbit metal journals, tool rest, trough and drip can, each 11.85
Stones, Grind, Sundries:
Arbors, complete, each..... 4.00
Bucket, Pan and Shield, each..... .79
Treadle, each 1.26

Stones, Oil, Red Washita, unmounted, 8x2x1⅛ in., each .32½
Stones, Oil, Red Washita slips, 4x2 in., round edges, each .09
Tools, Carving, set of six assorted, with oil and slipstone, and one carver's marker, handled with round handles, per set 2.16
Tray, Whittling, to be furnished with steel try square, 3 in. boxwood gauge, 5 in. sloyd knife, best quality, each... 1.20
Veneering, Black Walnut, per sq. foot..... .04
Veneering, Mahogany, per sq. foot..... .04
Veneering, Maple, per sq. foot..... .03
Veneering, White Holly, per sq. foot..... .06
Vises, 3 in. jaws, each..... 1.39
Vises, Saw-filing, 12½ in. jaws, each..... 1.54
Wax, Bees, per lb..... .27
Wax, hard, finish, per lb..... .23

Wood:

⅞ in. Clear Ash, 10 in. wide, dressed both sides, in 3 ft. lengths, per crate of 25 pieces..... 7.50
⅛ in. Bass Wood, clear, dressed both sides, in blanks, 4x9 in., per hundred..... 1.10
3-16 in. Bass Wood, clear, dressed both sides, in blanks, 4x9 in., per hundred..... 1.15
¼ in. Bass Wood, clear, dressed both sides, in blanks, 4x9 in., per hundred..... 1.20
⅝ in. Bass Wood, dressed both sides, in 3 ft. lengths, per crate of 25 pieces..... 5.50
5-16 in. thick, 6 in. wide, 6 ft. long, Bass Wood, per foot ..... .04
⅜ in. Gum Wood, dressed both sides, in 3 ft. lengths, per crate of 25 pieces..... 5.75
1⅞ in. square Clear White Pine Joist, dressed four sides, in 3 ft. lengths, per crate of 25 pieces..... 4.25
1⅞ in. square Clear White Pine Joist, dressed four sides, in board lengths, per ft..... .04¼
3 in. square Clear White Pine Joist, rough, in 3 ft. lengths, per crate of 25 pieces..... 8.50
3 in. square Clear White Pine Joist, in board lengths, dressed, per ft..... .09
⅜ in. Clear White Pine, dressed both sides, in 3 ft. lengths, per crate of 25 pieces..... 6.50
⅜ in. Clear White Pine, dressed both sides, in board lengths, per ft..... .07
⅞ in. Clear White Pine, 10 to 12 in. wide, dressed both sides, in board lengths, per sq. ft..... .09½
⅞ in. Clear White Pine, as above, in 3 ft. lengths, per crate of 25 pieces..... 8.25

7/8 in. square White Pine Strips, dressed four sides, board lengths, per lineal ft.	.02
1 7/8 in. square Clear White Wood Joist, dressed four sides, in 3 ft. lengths, per crate of 25 pieces.	4.00
1 7/8 in. square Clear White Wood Joist, dressed four sides, in board lengths, per ft.	.04
3/8 in. White Wood, dressed both sides, in 3 ft. lengths, per crate of 25 pieces.	5.00
5/8 in. White Wood, dressed both sides, in board lengths, per sq. ft.	.06
5/8 in. White Wood, as above, in 3 ft. lengths, per crate of 25 pieces.	5.50
1/2 in. square White Wood Strips, dressed four sides, board lengths, per lineal ft.	.01 1/4

The specifications for the workshop benches of the New York City schools are as follows:

"The following conditions apply to all the materials and work of every kind hereinafter named and described. All work to be in accordance with the specifications and plans.

The Contractor to furnish all materials and perform all work necessary for the proper completion of the contract; all material to be of the best quality and the work performed in a first-class manner, and completed within 45 working days after date of order.

All the furniture hereinafter named is to be furnished and delivered in the workshop, fitted and secured in place as directed—and MUST be so constructed that it can be shipped in sections if necessary for convenience in handling and delivering in place in the building.

All *Butts* must be ball-tipped, polished cast brass, of specified sizes.

All *Locks* must be cylinder locks, of "Yale" or other approved make, and of suitable size—all locks to have two keys.

Work Benches: The framework, doors and tops to

be of clear and thoroughly seasoned maple—the tops to be 2¾ inches thick, made of strips about 1¼ inches thick, glued together. Doors to be numbered from 1 to 30 with black painted figures one inch in height; doors hung on 1½ x 2 inch butts and secured by approved locks;

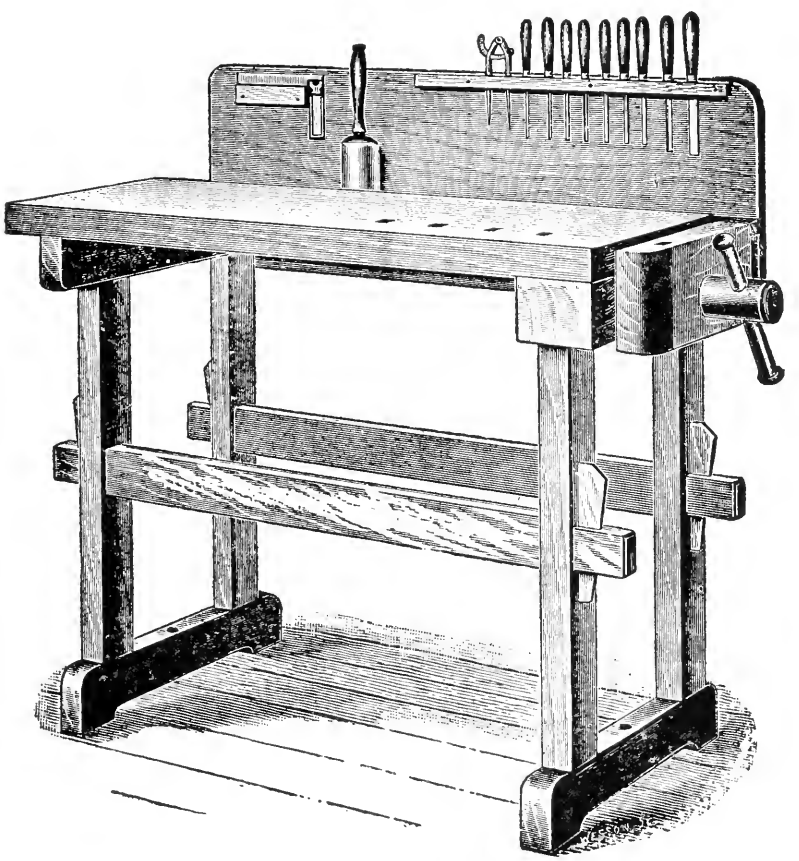


Fig. 26. Wood Carving Bench.

every key to have a separate brass tag attached by metal ring; tag to be stamped with a number corresponding to that of the door which the attached key locks.

Each bench to be fitted with two iron bench hooks and two "quick" action wood-worker's vises of iron, to be of

approved make, with 10-inch jaws, to open 12 inches; face of jaws to be planed smooth and faced with 1-inch maple.

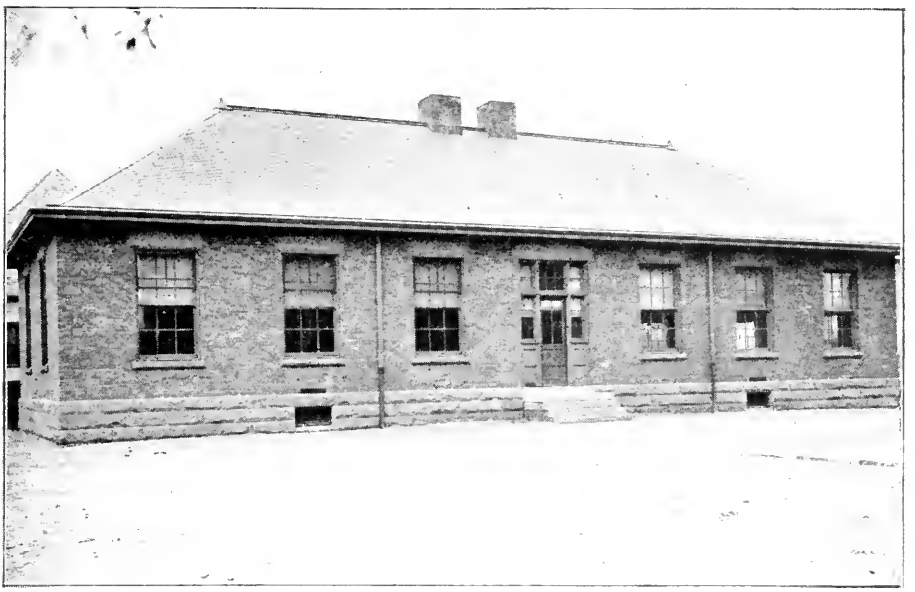
The facing on the fast jaw must, when faced, be flush with edge of bench top.

All necessary bolts and straps to be furnished, as shown on detail. Exposed woodwork of benches (except the tops) to be varnished two coats. Tops to be one coat of linseed oil."

An inventory of all tools and apparatus should be made by the teacher at the close of the school year. Blanks for the purpose may be supplied by the school authorities. Deficiencies in the equipment should be made up so that at the opening of the school term a full and complete working equipment is on hand. For this purpose, and also for the supplying of incidental needs, a form of requisition blank should be provided. The blank should contain a printed list of all tools and supplies in use, with blank spaces reserved in which to enter the number of each item required.

Wood Carving.

If desired, wood carving may be conducted in the wood-working shop by adding to the tool equipment twenty-four sets of carving tools listed at $3.25 per set. If a separate room is provided for wood carving regular carving benches, which range from three to five inches higher than the joinery bench, should be installed. Fig. 26 represents a type of carving bench that lists at $8.00.



Wade Park Manual Training Center, Cleveland, Ohio.

Manual Training Centres.

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An efficient and economical provision for manual training equipment in the upper grammar grades is the establishment of manual training centres. These centres may consist of either one or two rooms in a school building or a separate building erected solely for manual training. The centre accommodates the pupils of a district comprised within a certain radius. In such an arrangement the manual training work is usually placed either during the first or last period of the school session, thereby causing a minimum loss of time in going and coming between the regular school and the manual training shop. For example, a pupil enrolled for the first morning period would report for manual training at nine o'clock, the

same as at his regular class room. He then loses only the time required to make the journey back to his regular school after he has had his work in manual training. Again, the boy having manual training during the last morning period goes direct to his home, thereby losing only the time required to reach the manual training school.

A type of centre installed in a special building is found

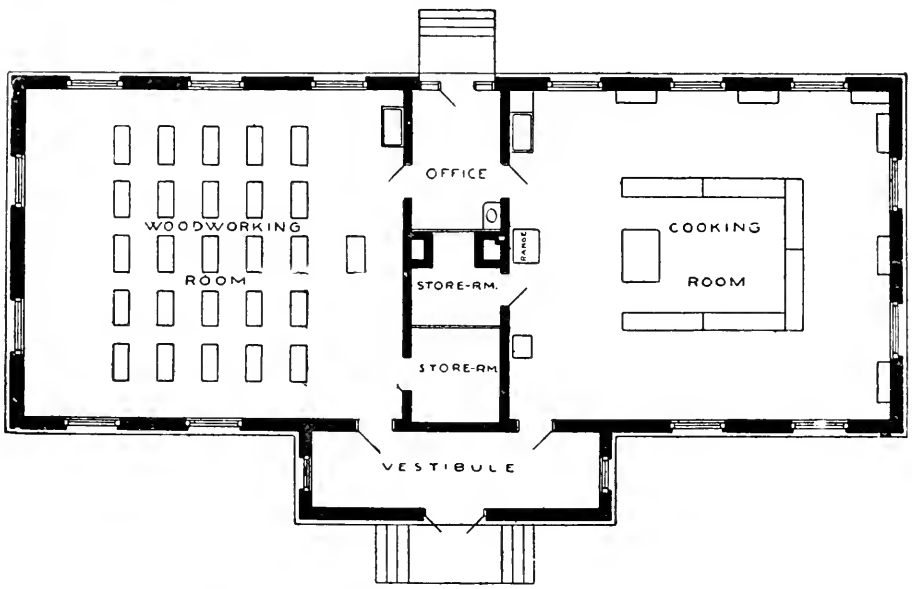

Fig. 27. Wade Park Manual Training Centre, Cleveland, Ohio.

in the Wade Park Manual Training School, of Cleveland, Ohio, a view of which is shown on page 91, and plan in Fig. 27.

The cost of the building and equipment is given below:

Building, including mason and cut-stone work, carpenter work, painting, glazing, plumbing, gas-fitting, sewers, heating, and ventilating, galvanized iron work, tin and slate roofing, blackboards, and all extra work on buildings	$4,548.00

27 benches	135.00
Tools	120.03
52 stools	23.83
7 cooking school tables	65.00
Case for dishes	8.25
5 cases for caps and aprons	130.00
Dishes	47.39
Gas and coal ranges	44.75
Toweling, etc.	9.98
Office desk	8.75
6 chairs	6.00
2 teacher's tables	9.00
Sundries, estimated at	30.00
	$5,185.98

The building is equipped to accommodate from 600 to 700 boys and girls, under the direction of two teachers. The pupils are divided into thirty classes, fifteen classes in wood work and fifteen in cooking. Each class works one period of one and one-half hours each week.

The cost of supplies, wood, drawing-paper, cooking materials, etc., averages about twenty-five cents per pupil per week.

Another admirable type of the Manual Training centre is afforded by Evanston, Ill. (Figs. 28-30.) The following reference to the inception of the school and description of its equipment is taken from the prospectus of the school.

"The Schools of Manual Training and Domestic Science in Evanston are the outgrowth of an offer on the part of two public spirited citizens to co-operate with the Board of Education in establishing such schools and paying the salaries of the instructors. As a result of this co-operation an attractive building was erected near the centre of the district for the exclusive use of these departments. No effort has been spared to make the housing, equipment, and instruction the best that modern standards can produce from artistic, sanitary, and scientific standpoints.

"The equipment of the kitchen laboratory is very complete in every detail. A great deal of time and thought has been expended upon this department with the result that it represents both beauty and utility in a high degree without suggesting an unwise or extravagant expenditure of money. All things considered it is probably the best equipped school of its kind in the country.

"The room is large and sunny, being provided on three sides with fourteen large windows, and with a floor space 30 by 50 feet. The artistic effect of the room has been enhanced by a color scheme of blue, white, cream, and mahogany, to suggest the style of an old Dutch kitchen. The walls are covered to the top of the doors with blue buckram so finished as to be easily cleaned. At the height of the doors a shelf extends around the room. The walls above the shelf, and the ceiling are a deep cream color. The windows are curtained with cream colored shades, and sash curtains of Russian crash in natural color edged with blue fringed gimp. The door and window frames and the shelf are painted ivory white, while the doors and base-boards are mahogany color. On the shelf extending around the room is an interesting collection of vases, plates, jars, etc., representing the wares of different nations. This collection will be added to from time to time. Three large cupboards with leaded glass doors in Dutch style are built across the corners and on one side of the room, and contain china in blue and white, and a food museum.

"The furniture of the room includes twelve mahogany chairs, a mahogany tea table for use when guests are entertained; a hooded gas range, large white tile icebox, teacher's demonstration table, fitted with deep drawers

where chemicals and chemical apparatus are kept, a teacher's chair and supply table. The sinks are three in number, all white porcelain, nickel trimmed. The laboratory table is in the form of a hollow square with complete

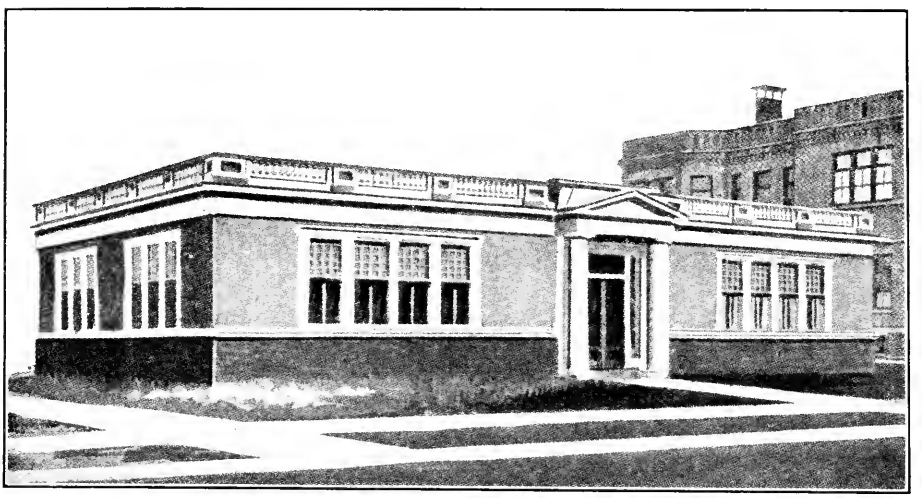

Fig. 28. Manual Training Center, Evanston, Ill.

equipment for 24 pupils. The front half of the tops of the tables is fine matched maple and the back half is of white vitrified tile, which affords a protection from the individual gas stoves and ovens. Each pupil has a drawer containing a complete equipment, also a drawer for food supplies, a bread board, cutting board, and seat, all fitting into the table. The legs of the table are nickel, and a nickel band two inches in width is carried all around the table as a support to the tile fittings and a finish to the edges of the tables. The floor is covered with linoleum of artistic design, carrying out the color scheme of the room.

"The latest and most approved system of heating, lighting, ventilating, and plumbing has been installed. The

store rooms, toilet rooms, etc., are complete and in harmony with the general equipment. In addition to the above the room is furnished with sets of meat charts, food charts, and a blackboard.

"The following is a complete list of the working equipment:

Tin, Granite and Iron Ware.

1 Fifty lb. Columbia flour bin
24 Pine granite double boilers
12 Japanned tin pepper boxes
12 Salt boxes
12 Flour boxes, half-pint
12 Sugar boxes, half-pint
1 Spice boxes, set of 6
3 Four qt. blue enamel bowls
3 Tin collanders
12 Half-pint granite coffee pots
48 Measuring cups, half pt., 3ds, 4ths
4 Henis fruit presses
8 Wire frying baskets
1 Garbage pail and cover
8 Iron cake griddles
12 Iron dish cloths
3 Blue enamel Berlin kettles,
24 Half-pint granite sauce pans
8 Two-qt. granite sauce pans
3 Quart pans
6 One-qt. blue enamel pitchers
3 Small tin scoops
24 Small wire strainers
1 Berlin Kettle, 3 qts.
1 Tin quart measure
1 Large Russia ware pan
24 Fourth lb. Russian ware bread pans
24 Small tin pans for molding
24 Small baking pans
24 Small pie pans
24 Small deep pudding pans
12 Six-inch pie pans
2 Six-qt. pans
24 Utensil pans
12 Granite dishpans
12 Rinsing dishpans
24 Granite qt. pans
24 Small steel frying pans
1 Tin gem pan
2 Iron gem pans
1 Soup strainer
12 Blue enamel soap dishes
2 Large tin steamers
1 Waffle iron
1 Six-qt. tea kettle

Small Utensils, Cutlery, Etc.

12 1¾ in. biscuit cutters
12 Ditto cooky cutters
1 Corkscrew
1 Can opener
12 Surprise eggbeaters
12 Dover eggbeaters
1 Meat fork
24 Rogers Bros. dinner forks
1 Small tin funnel
6 Graters
1 Large sharp knife
1 Ice pick
6 Mincing knives
24 Rogers Bros. silver plate knives
24 Paring knives
1 Wire potato masher
24 Sultana tablespoons
24 Sultana teaspoons
24 Bone salt spoons
1 Large granite spoon
24 Small wooden spoons
24 Silver plated teaspoons
24 Eight-in. spatulas
1 Steel for sharpening knives

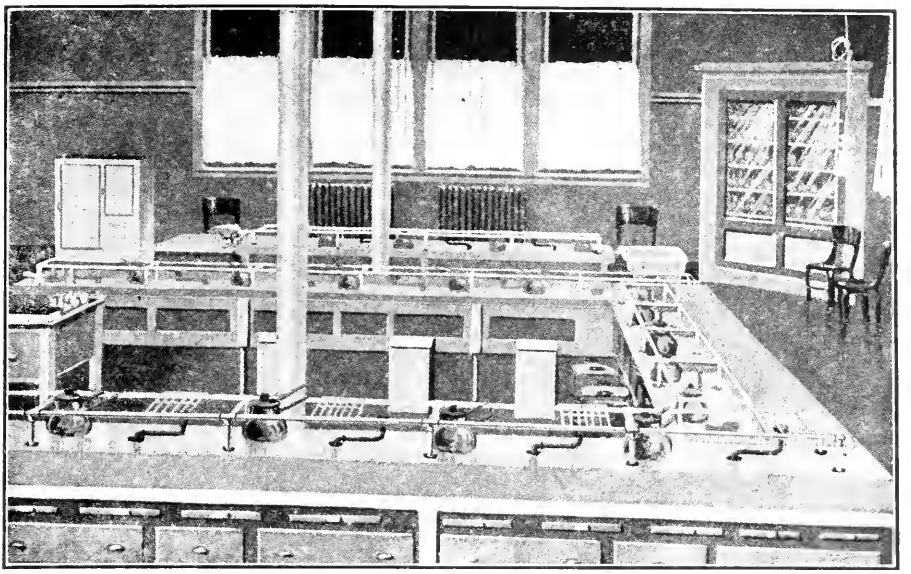

Fig. 29. Cooking Laboratory Manual Training Center, Evanston, Ill.

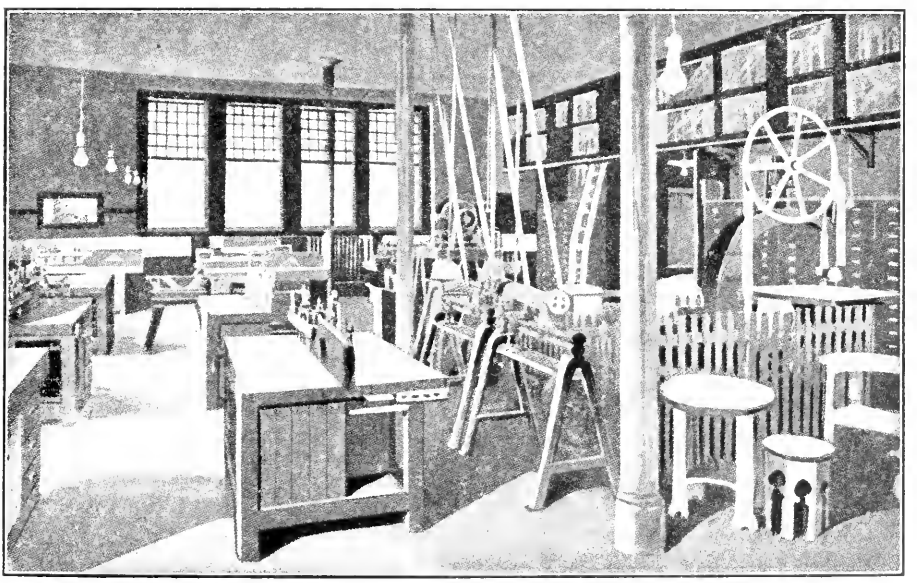

Fig. 30. Wood Working Manual Training Center, Evanston, Ill.

Wooden Ware, Etc.

1 Teacher's chair
1 Mop
6 Wooden chopping bowls
12 Small scrubbing brushes
12 Vegetable brushes
1 Stove brush
1 Long handled dust brush
3 Short handled dust brushes
2 Radiator brushes
1 Coffee mill
3 Wooden mallets
1 Four-lb. tea scales
1 Refrigerator brush
12 Sugar buckets
12 Butter pots
1 Wooden bench
24 Asbestos mats
12 Toy rolling pins
1 Large rolling pin
1 Six-qt. pail
1 Clothes rack
1 Kitchen table
1 Ice box
12 Ovens

Crockery, Glass, Etc.

24 Six-in. plates
6 Eight-in. plates
1 Platter
1 Cake plate
4 Cream pitchers
24 Soup plates
28 Sauce plates
36 Tumblars
26 Individual teapots
6 Two-qt. glass jars
3 Bean jars
6 Glass lemon squeezers
28 One-pt. earthen bowls
28 One-qt. ditto
8 Half-pt. bowls
30 Small Coffee cups
12 Earthen cups

Miscellaneous.

4 Diet charts
4 Meat charts
Pratt Institute Food Museum
1 Silver tray
2 Aluminum trays
6 Dish mops
24 Piercing needles
24 Fryingpan covers
Toweling in quantity

Chemical Apparatus.

Bunsen burner, test tubes, test tube rack, special thermometer, tube holder, rubber tubing, tube brush, test pan.

Wood-Working Shop.

"The equipment for the wood-working shop includes tools sufficient to give thorough instruction to classes of 24 pupils each in general bench work, wood carving, wood turning, and finishing.

"There are in all 216 private lockers each containing a set of firmer chisels, and a plane blade and cap, thus providing each pupil with individual edge tools. The shop is equipped with 12 double benches each provided with two sets of general tools such as saws, hammers,

squares, gauges, plane stocks, measuring scales, etc., and complete sets of carving tools.

"In the general shop equipment ample provision has been made in auger bits, assorted twist drills, expansive bits and braces, draw knives, spoke shaves, scrapers, rasps, hand and cabinet clamps.

"The shop is also provided with a 30-inch band saw, a complete 10-inch circular sawing machine, a 30-inch grindstone, a 4 x 8-inch trimmer, and 12 11 x 26-inch speed lathes."

Mechanic Arts High School, Boston, Mass.
Plans on pp. 165.

The High School.

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Joinery Shop.

The first-year class in the high school requires much the same equipment as that provided for the upper grades and usually does the same general line of work, though more advanced in character. The cost per pupil for maintenance, as shown by a number of returns, is about $1.00.

Wood Turning and Pattern Making.

This subject is generally introduced in the second

year of the high school course. In addition to the joinery equipment, lathes and lathe tools are required. We are here confronted with a large item of expense not heretofore met with; that of power. This may be furnished either by an engine on the premises supplying power direct or through a dynamo and moters, or it may be furnished through motors driven from an outside supply of current. Shafting, pulleys, couplings, hangers, of which more or less are required according to conditions, may be calculated at fifty per cent. less than list prices as given in the catalogue of a reliable dealer.

In schools having only a bench equipment, and without power, one or more foot-power lathes are sometimes introduced for limited use.

The work in wood turning and pattern-making may be carried on in the joinery-room by the addition of the required lathes and appurtenances, but where conditions admit a separate room should be provided. This will necessitate a duplication of the bench equipment. As the bench equipment has been considered in detail above, only the extra equipment necessary for wood-turning is here dealt with.

A special form of combination bench, used in Boston and at the State Industrial School, at Rochester, N. Y., is shown in Figs. 38–39. The mounting of the bench lathe is clearly shown in the illustration. Directly back of the lathe is the bench proper. This bench is described somewhat more in detail on page 109.

The principal parts of a wood-turning lathe are the bed, head-stock, tail-stock, and tool rest.

The Lathe Bed—the largest part—is cast in one piece, varying in length, for school purposes, from three to four feet. The top is finished in two V's, extending the

length of the bed, upon which the head-stock is permanently fastened, and upon which the tail-stock travels and is clamped in any desired position. The V's either extend above the surface of the bed, or are grooved into the surface. Between the V's is an open space to facilitate the clamping of the tail-stock and tool-rest in position.

Legs. The bed is supported by two pair of legs fastened to the bottom at either end. These legs are either long, reaching to the floor, or quite short, to permit of the lathe being placed upon a bench. In the latter case the lathe is termed a bench-lathe. Lathes with long legs are shown in Figs. 30-32, and bench-lathes are shown in Figs. 33, 38 and 39. When reaching to the floor the legs should have a wide spread to insure stability and firmness.

Head-Stock. The head-stock is fastened to the extreme left hand end of the top of the bed. Its purpose is to give the required revolution to the work, at varying speeds. These varying speeds are secured by the aid of the cone-pulley, which is merely a collection of pulleys, from three to four in number, of varying diameters. The cone pulley is made fast to a spindle which is usually supported at either end by two bearings, but there is a form of an overhung cone-pulley having but one bearing. The head-end of the spindle is threaded to receive a face-plate and has also a tapered hollow to clutch a "centre." A large and a small face-plate are usually a part of the equipment that is furnished with each lathe.

Tail-Stock. The tail-stock is placed on the right hand end of the bed and has also a tapered hollow to clutch a "centre" in perfect alignment with the "centre" of the head-stock. It is between these two centres that the wood

to be turned swings, and a lathe is known as a "10-in. swing" or "11-in. swing" according to the maximum diameter of the work that will swing freely between the line of the centres and the bed of the lathe. The bottom of the tail-stock is provided with two V's to fit the V's of the bed,

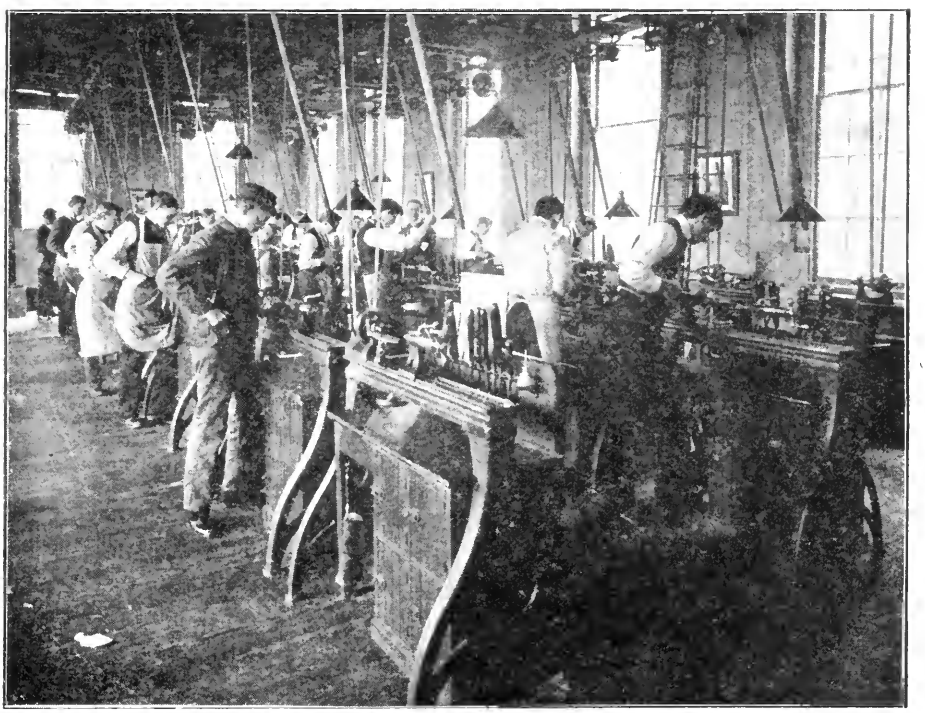


Fig. 31. Wood Turning Equipment, Pratt Institute, Brooklyn, N. Y.

and to permit of its being shifted to the right or to the left to accommodate varying lengths of wood. The maximum lengths—or "distances between centres"—varies from 16″ for a 3-ft. bed to 30″ for a 4-ft. bed. The tail-stock is secured in any desired position by a clamping device of one form or another, and operated either at the side or at the bottom. At the right-hand end of the tail-stock is a hand-wheel to control a limited variation of the

distance between centres. A lever feed is also sometimes used for this purpose.

Tool Rest. The tool-rest proper is a T shaped piece for resting the turning tool upon. It is supported by a carriage, designed to permit of its being swung about into a variety of positions, and has also a clamping device for securing it in position. Like the tail-stock it is provided on its under side with V's, and for the same purpose. Two or three tool-rests of varying lengths are usually supplied with each lathe.

Counter Shaft. Part of the regular equipment for each lathe should include the counter shaft. A somewhat common form has a wide central bearing that is fastened to the ceiling block. The spindle, carried by this bearing, has at one end a cone-pulley corresponding to that of the lathe and hung in reverse order, and at the other end a fast and a loose pulley, belted to the main shafting. These pulleys are commonly mounted on a shaft which has bearings at either end.

The belt is shifted from one to the other of the pulleys by a belt-shifter, the handle of which extends down within easy reach of the operator. The belts from the main shaft may be 1¾" in width, and the belt from the counter shaft to the lathe 1½". For wood-turning the counter-shaft should be run at about 500 revolutions per minute which will permit of a maximum speed at the rate of 2,000 revolutions per minute.

Fig. 32 shows a lathe that has been specially designed for manual training schools, to meet the demand for a lathe at a moderate price. It lists at $35. Much is claimed by the manufacturers for the unique arrangement of the shafting which does away with overhead counter-shafting, permits of installation in a building

of light construction, and also greatly reduces the cost of installation.

Fig. 32. Wood Turning Equipment Without Overhead Shafting.

Each lathe should be provided at the back with a shelf and tool rack. A lathe having the following general specifications is well adapted to school conditions: 10″ swing over bed, length of bed 3½ feet, distance between centres 24 inches, weight with long legs 250 lbs., weight with short legs 200 lbs., floor space over all 3 feet 10 in. x 26 inches. Such a lathe, complete with countershaft sells at about $45.00 Some lathe manufacturers make a lathe especially for school use and will gladly furnish information upon request.

A full set of working drawings of a wood-working bench lathe is shown in Figs. 33-37. These drawings may serve for a machine-shop project. This particular lathe has served such a purpose in one of the large manual training schools where a number of these lathes are in use.

A foot-power lathe costs about $25.00. A lightly constructed foot-power lathe, with scroll saw and circular saw attachment, retails for $13.00.

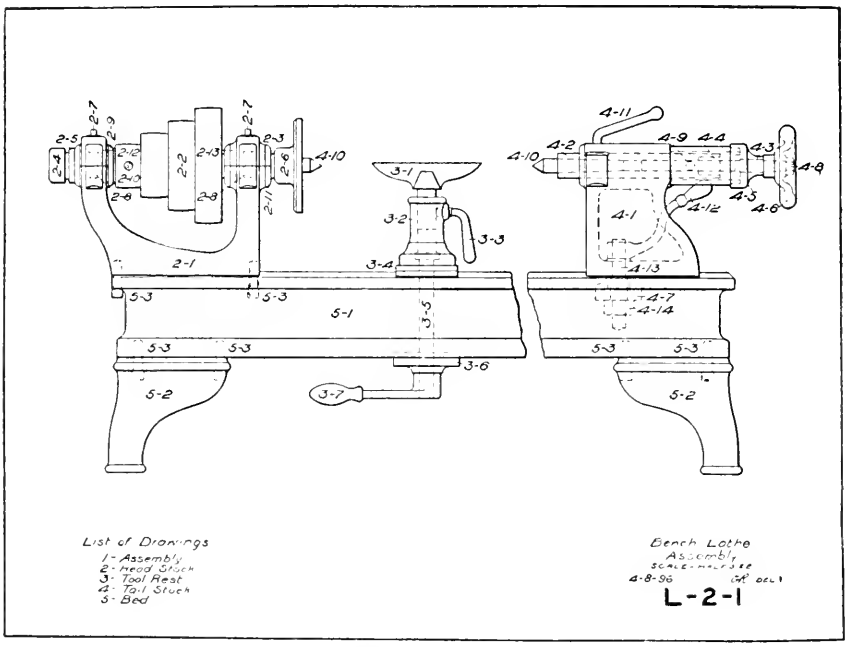


Fig. 33. Bench Lathe—Assembly.

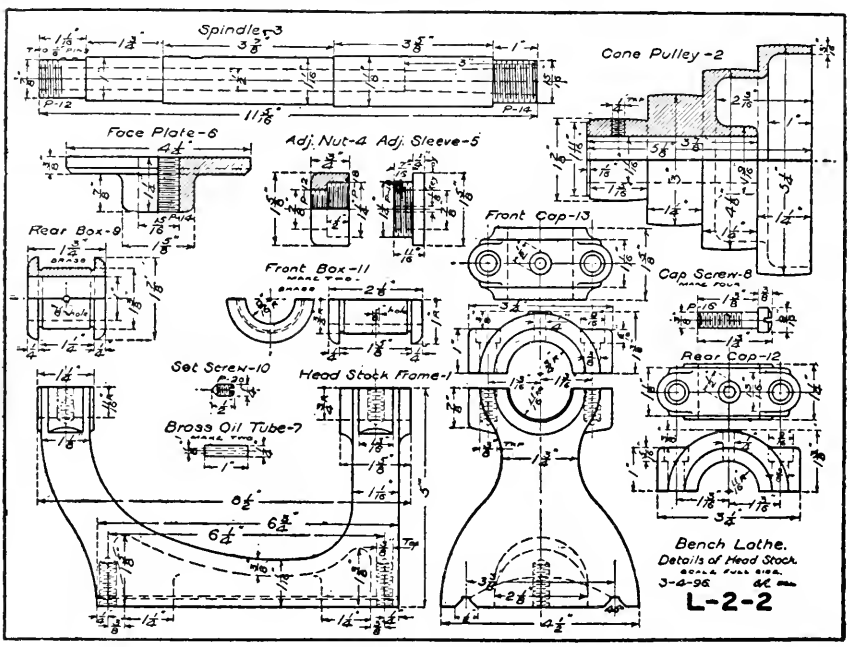


Fig. 34. Bench Lathe—Head Stock.

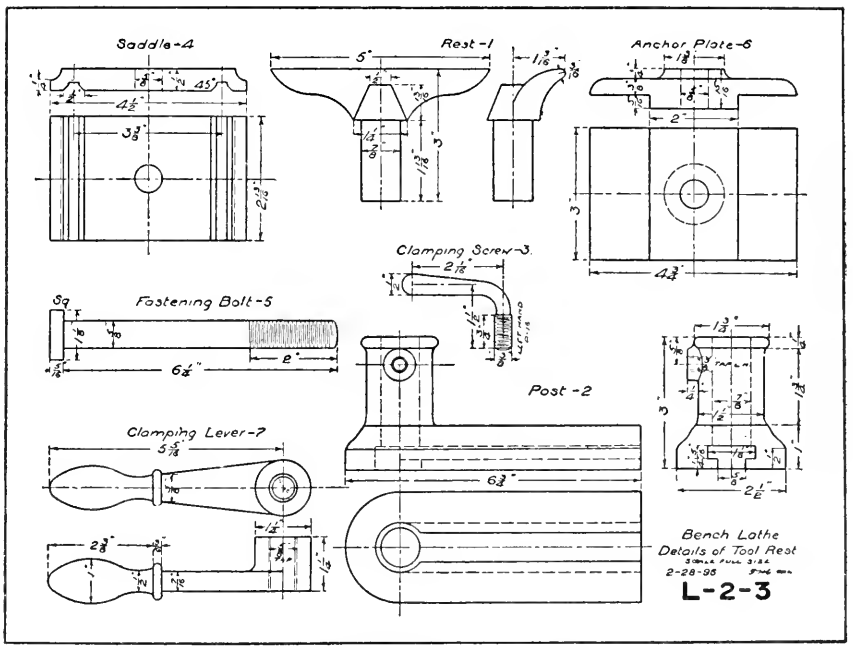


Fig. 35. Bench Lathe—Tool Rest.

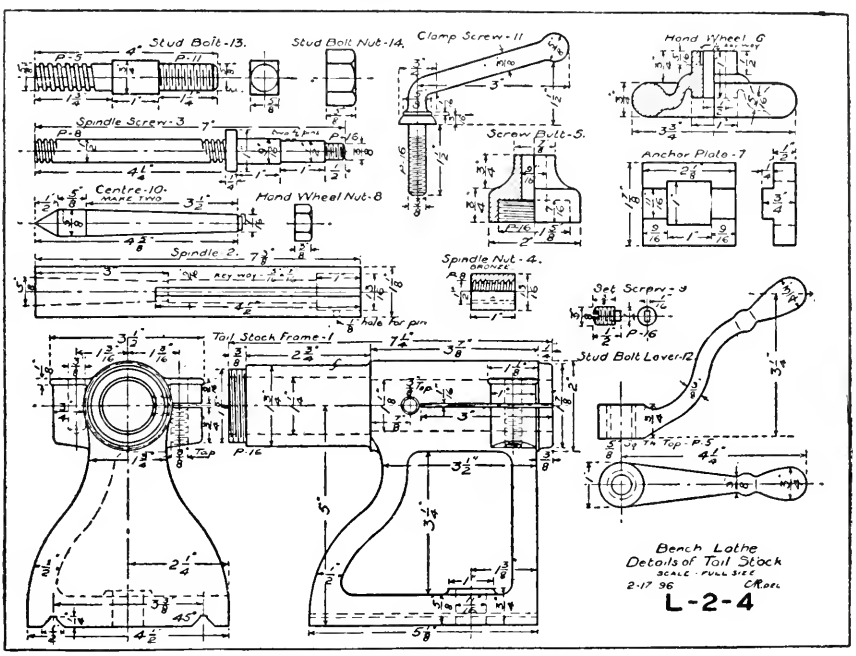


Fig. 36. Bench Lathe—Tail Stock.

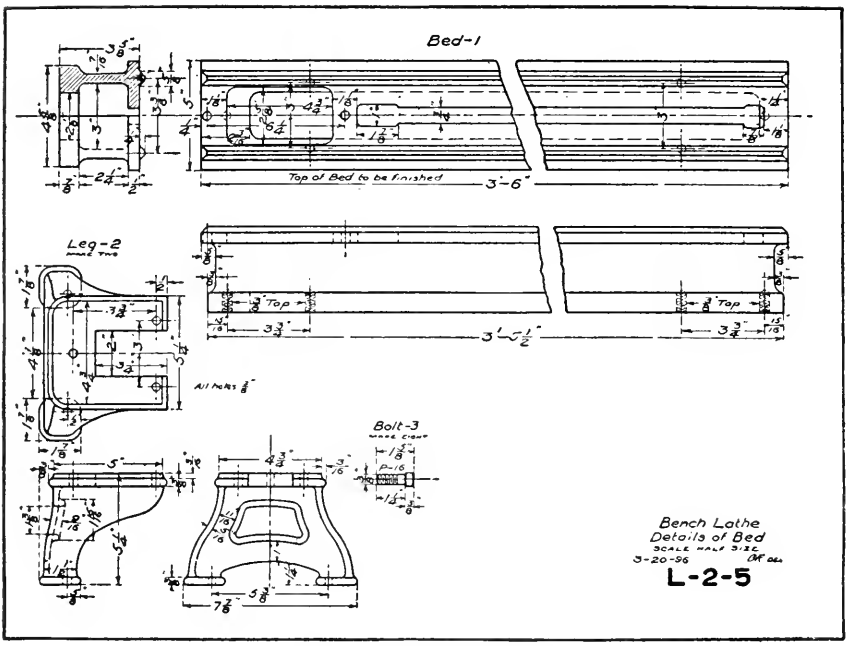


Fig. 37. Bench Lathe Bed.

Individual Tools.

A comprehensive tool equipment for each lathe is as follows:

Turning gouges, ½ in. and ¾ in.	$ .54
Flat turning chisels, 5-16 in. and ¾ in.	.60
Round-nose chisels, 5-16 in. and ⅝ in.	.47
Square chisels, ¼ in. and 1 in.	.42
Parting tool, 3-16 in.	.37
Paring gouges, ½ in. and 1 in.	.94
Washita, oil-stone	.49
Washita, slip stone	.03
Pair 6-in. calipers	.61
Oil can	.20
Dust brush	.23
Rule	.10
Total cost of tools for each lathe	$5.00

General Tools.

Power driven circular-saw	$175.00
Power driven band-saw	65.00
Power driven grindstone	25.00

Power driven planer	100.00
Universal mitering machine, 8 in. stroke	32.00

The two last named tools are desirable but not necessary.

According to the above specifications the total cost of the addition to the joinery equipment, exclusive of power plant, would be $1,847.00, divided as follows:

24 Lathes, at $45	$1,080.00
24 Sets of tools, at $5	120.00
General tools	397.00
Pulleys, shafting, hangers, belting, etc. (estimated)	250.00

On pages 67–70 is quoted a detailed description of a joinery equipment. A further quotation from the same source, descriptive of the wood-turning and pattern-making shop, is here inserted because of its suggestions.

"In the wood-turning and pattern-making room (Figs. 38-39) there are thirty-six benches. On one side of the bench is a Putnam 11-in. speed lathe, the other side is used for work with hand tools. As in the other wood-working rooms, these benches are fitted with 9-in. Wyman & Gordon quick-action vises.

"Beneath the lathe is a tier of three drawers, each containing a set of turning tools. On the opposite side, under the work bench, is a tier of four drawers. The top drawer in this tier is devoted to the measuring and miscellaneous tools used in common by members of different classes, while each of the three others contains an individual set of cutting tools.

"Individual turning tools:

Buck Brothers tools: gouges, No. 20, one each, 1/4, 1/2, 5/8, 1 1/4 in.; chisels, No. 19, one each, 1/4, 1/2, 3/4, 1 1/4 in.; No. 103, 3/8 in.; No. 104, 1/2 in.; parting tool, No. 18, 5/8.; a Washita gouge slip.

"Individual joinery tools:

Bailey's patent adjustable iron tools; one each, fore-plane, 18 in., No. 6; smoothing plane, 8 in., No. 3; spoke-shave, No. 51. Buck Brothers shank firmer chisels, No. 2, one each, ¼, ⅜, 1, 1½ in.; a gothic point knife; a Stanley marking gauge, No. 65; a whisk broom.

"Tools used in common:

Bemis & Call Co.'s tools; wing dividers, 7 in.; wing calipers, 6 in.; patent inside calipers, 6 in. Genuine Russell Jennings bits, one each, ¼, ⅜, ½, ⅝, ¾ in. Stanley Rule and Level Co.'s tools: try square, 6 in., No. 10; rule, 2 ft., No. 18; T bevel, 10 in., No. 18. A Maydole adze-eye bell-faced hammer, No. 13; a Bliss mallet, No. 3; a Buck Brothers screw-driver, 5 in., No. 69; a Spofford bit brace, No. 108; a Disston rip-saw, 22 in., D 8, with 8 teeth to the inch; a Disston cross-cut saw, 22 in., D 8, with 10 teeth to the inch; a Disston back-saw, 12 in., No. 4; a bench hook, 12x8x1 in.; two winding sticks, 18x2x½ in.; a Washita oil stone, 8x2x1⅛ in., in box; a brass paragon oil can, No. 0; a Chase patent brass oiler, No. 2; a dust brush.

"Conveniently located in the centre of the room are two grindstones and a Putnam pattern-maker's lathe having an 8-ft. bed and, with open slide, capable of doing work 36 in. in diameter. This lathe is fitted with the most approved devices for doing all kinds of work, and is designed to be used only by the instructor and by pupils who develop special skill and demonstrate their ability to do a higher order of work. Near at hand is a small tool-room which contains a large variety of minor supplies, and all miscellaneous tools likely to be needed. The loft above this room furnishes adequate storage for a year's supply of lumber.

"In one corner of each of the three wood-working rooms is an amphitheatre in which the entire class may be seated so that each member can see plainly the work done by the instructor at the demonstration bench. The space behind the amphitheatre has been utilized to provide a convenient place for sinks and mirrors. A copper tank containing four glue pots heated by steam is installed in each wood-working room. Large cases are provided

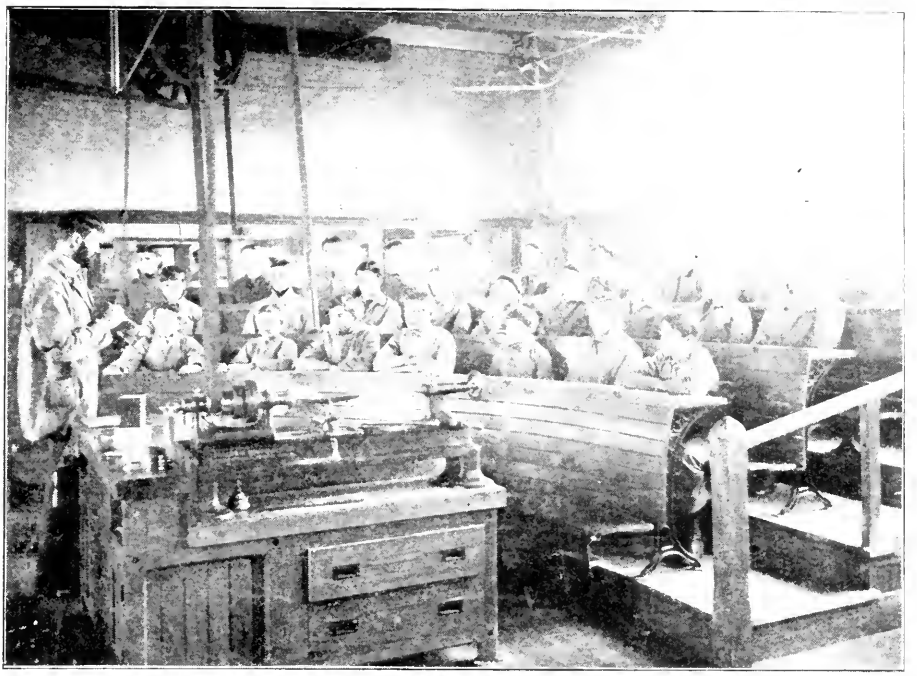


Fig 38 Demonstration Theatre, Mechanic Arts High School, Boston, Mass.

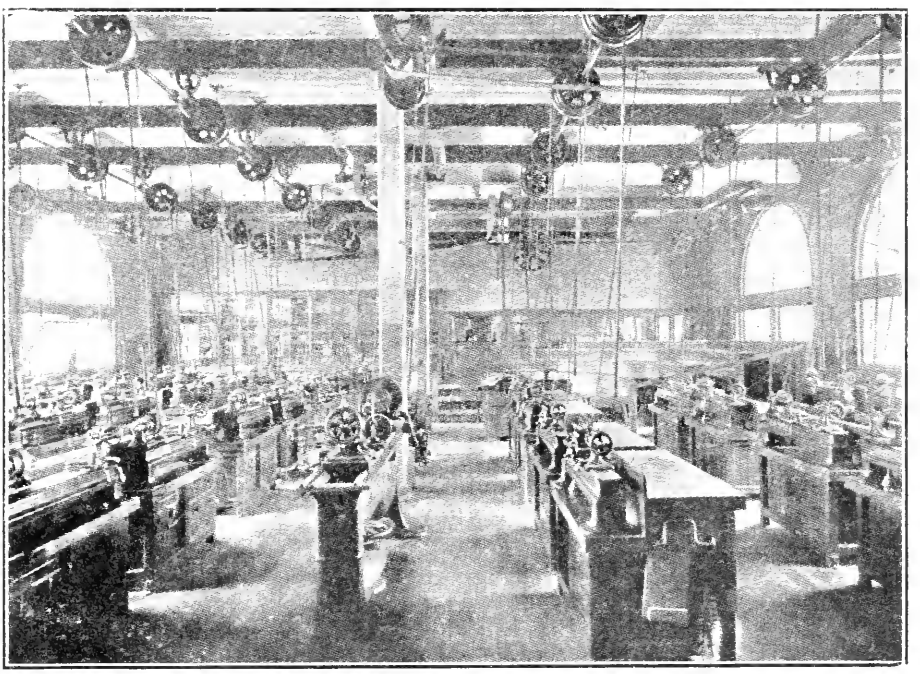


Fig. 39. Wood Turning and Pattern Making Shop. Mechanic Arts High School, Boston, Mass.

for the convenient storage of prepared stock and finished work.

"The frames of drawing tables and work benches, and all exposed parts of tables, benches, and cases, are ash; the sides of drawers, interior of cases, and tops of drawing tables are white pine; the tops of work benches are of narrow strips of maple glued together to prevent warping. All drawers and compartments of cases are fitted with locks, no two of which have the same combination, but all are operated by a master key. The tables and benches have been constructed in the most thorough and substantial manner, and no pains have been spared to make every part of the equipment illustrate excellence of design and workmanship."

The following equipment is used by the Lewis Institute, Chicago, the approximate cost of which is $9.00 for the individual set and $10.00 for the general tools.

Individual Equipment at Each Bench.

1 No. 5 Bailey iron jack plane
1 No. 4 Bailey iron smooth plane
1 No. 9½ Bailey iron block plane
1 No. 62 Stanley marking gauge
1 No. 32 ¼-in. paring chisel
1 No. 32 ½-in. paring chisel
1 No. 32 ¾-in. paring chisel
1 ¼-in. turning gouge
1 ¾-in. turning gouge
1 ¼-in. turning chisel
1 ¾-in. turning chisel
1 No. 14 India slip stone
1 ⅝-in. parting tool
1 5-in. inside spring caliper
1 5-in. outside spring caliper

Bench Equipment at Each Bench.

1 No. 8 20-in. crosscut saw
1 No. 8 20-in. rip saw
1 No. 8 10-in. back saw
1 ⅜-in. mortise chisel
1 No. 2 hickory mallet
1 Wood bench hook
1 No. 29 India oil stone
1 No. 12 steel oil can
1 Plain N. P. brace
1 ¼-in. auger bit
1 ⅜-in. auger bit
1 ½-in. auger bit
1 ¾-in. auger bit
1 Cup point knurled nail set
1 Whittling knife
1 No. 18 8-in. T bevel
1 No. 12 8-in. Stanley try square
1 8-in. wing divider
1 5-in. screw driver
1 No. 12 claw hammer
1 Bench brush

Lathe tool equipment used at the Armour Institute of Technology, Chicago:

Each wood turning lathe has a case of six drawers, one large drawer containing the general tools and five small individual drawers, each of which contains the tools used only by the student having the key to that drawer. Each of the individual drawers contains the following tools:

1 ¾-in. turning gouge
1 ⅜-in. turning gouge
1 ¼-in. turning gouge
1 1¼-in. turning chisel
1 ¾-in. turning chisel
1 ⅜-in. turning chisel
1 ¼-in. turning chisel

In the sixth or large drawer of each lathe are the following tools for general use of the five students using that lathe:

1 6-in. outside wing caliper
1 4-in. plain outside caliper
1 4-in. plain inside caliper
1 6-in. wing divider
1 Scratch awl
1 6-in. T bevel
1 4½-in. adjustable try square
1 No. 51 Stanley rule
1 ¾-in. scraping tool
1 ½-in. scraping tool
1 ¼-in. scraping tool
1 each right and left special
1 Skew point scraping tool
1 Spear point scraping tool
1 ½-in. round point scraping tool
1 ¼-in. round point scraping tool
1 6-in. screw driver
1 6x2 Washita oil stone
1 4½ x 2¼ x ⅝ Washita slip stone
1 Oil can

Maintenance.

The cost for maintenance of a wood-turning and pattern-making course is somewhat higher than for joinery work. Returns from eleven schools give an average of $1.62 per pupil. To this must be added an allowance for loss and depreciation of equipment, which may be estimated at 10 per cent. of the cost of equipment per annum.

Foundry.

Foundry work sometimes occupies part of either the second or third year of the high school course. It is supplementary to the work in pattern-making. It requires a special room, situated preferably in the basement, that an

earthen or cement floor may be secured. Essential to an equipment is a furnace for melting the metal, ladles for pouring, a set of various small tools, a number of moulding flasks, moulding-troughs and a core oven. With a relatively inexpensive equipment of this kind castings may be made in white metal or lead. Where practicable

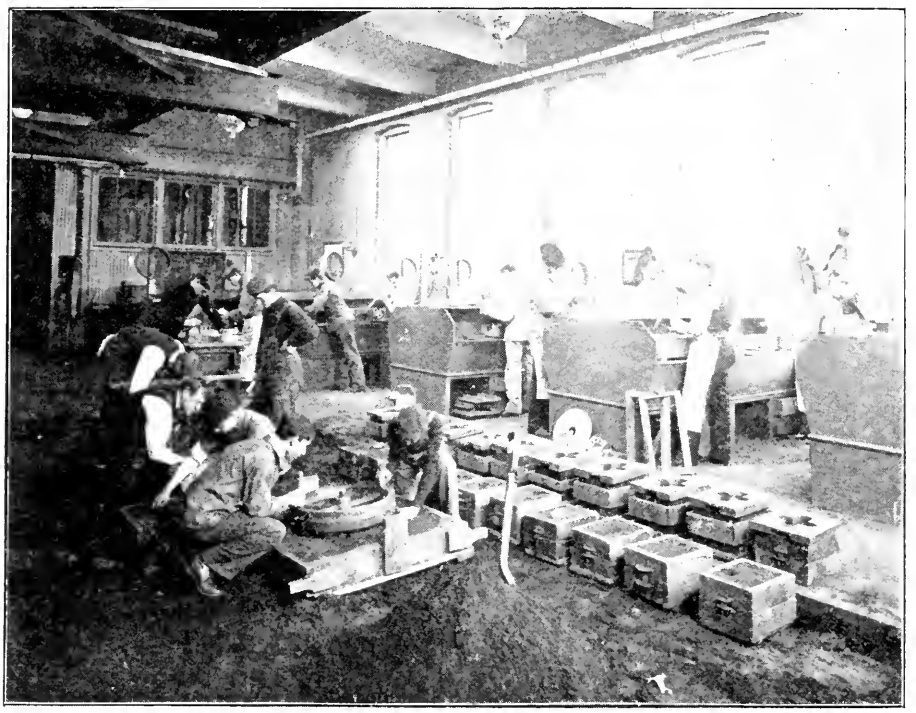


Fig. 40. Foundry Equipment, Pratt Institute, Brooklyn, N. Y.

a brass furnace may be added to this equipment thus allowing for castings in brass or bronze. Scrap iron is also successfully melted in crucibles in the brass furnace, but, of course, upon a small scale.

A more complete equipment, capable furnishing castings in iron would require a cupola, with its accessories; an expensive and generally impracticable installation.

In Fig. 41 is shown a moulding trough that lists on the market at $20.00. It is thoroughly built of pine throughout, and has drawers, etc., for containing all necessary tools. It is 4 feet long, 27 inches wide, and 4 feet high.

The equipment shown in Fig. 40 is a very complete one. The cupola and core-oven are to the left and are not

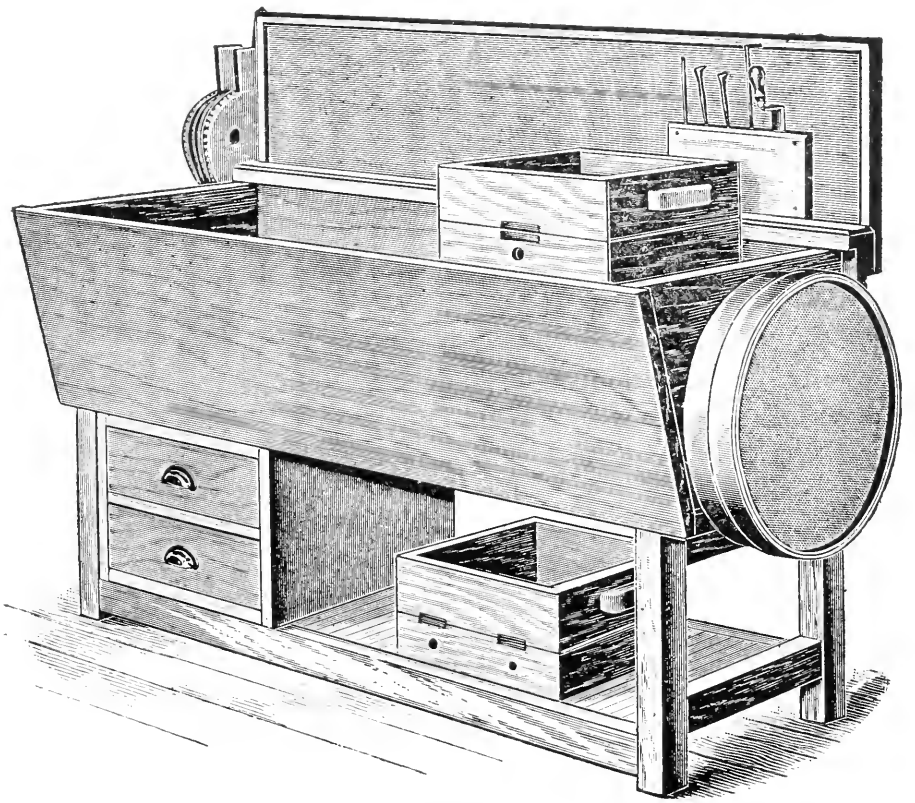


Fig. 41. Foundry Moulding Trough.

shown in the illustration. It will be noticed that the moulding-troughs are built in groups of four.

Equipment for Class of Twenty-four Students.

White metal furnace and blower	$ 58.00
Core oven	50.00

24 sand troughs	360.00
24 small flasks	15.00
Ladles, skimmers, etc.	10.00
Sand bins and shelves	30.00
24 student sets, consisting of: Rawhide mallet, 4-in. trowel, ½-in. Yankee slicker, ½-in. double-end slicker, parting sand duster, draw spike, brass gate cutter, swab-pot and swab, 16-in. mesh sieve, pair of rammers, soft brush, 2-ft. straight edge, short-handled fire shovel, and 7-in. bellows for each two students, at $9 per set	216.00
Total cost of equipment	$739.00
Double crucible furnace	100.00
Cupola	500.00

Maintenance.

If white metal or lead is used these materials can be remelted and reused. Molding and core sand must be provided, but can be reused, thus making the cost per pupil dependent upon the amount of waste and the cost of running the fire for the furnace. When lead or white metal is used and remelted this cost may come to perhaps 20 cents per pupil. If a cupola is used the expense per pupil, exclusive of depreciation, may reach as high as $1.20.

Forge Shop.

By referring to the table (opp. p. 7) it will be noticed that forge work is usually carried on during the second year of the high school, and in some instances it is made a third year subject. A large room in the basement is customarily provided for this work. The equipment is the most expensive of any of the shops thus far considered and the cost of maintenance is also the highest. A minimum equipment would consist of forges blown by hand-power, anvils, and the necessary tools. An up-to-date equipment calls for pressure and exhaust piping, preferably laid under the floor, pressure and exhaust

blowers, forges, anvils, and tools, to which may be added one or more power tools, as hammer, shears, drill press and drop press. These power tools are, however, more in accord with the purpose of the engineering school shop than with that of the high school shop.

Fig. 42. Forge Shop, Overhead Exhaust Piping, Pratt Institute, Brooklyn, N. Y.

The piping is a variable item, depending upon the situation of the forges in relation to the fans. The latest practice calls for down-draft forges with the pressure and exhaust piping laid below the floor. The underground tile piping possesses the advantages over the system of overhead piping that it does not obstruct space and light, is indestructible, and entails no further expense after initial installation.

Fig. 42 illustrates a forge-shop equipped with overhead piping, and Fig. 43 a more recently equipped forge-shop having underground tile exhaust and pressure ducts.

Locker and lavatory facilities should be provided. (Fig. 18).

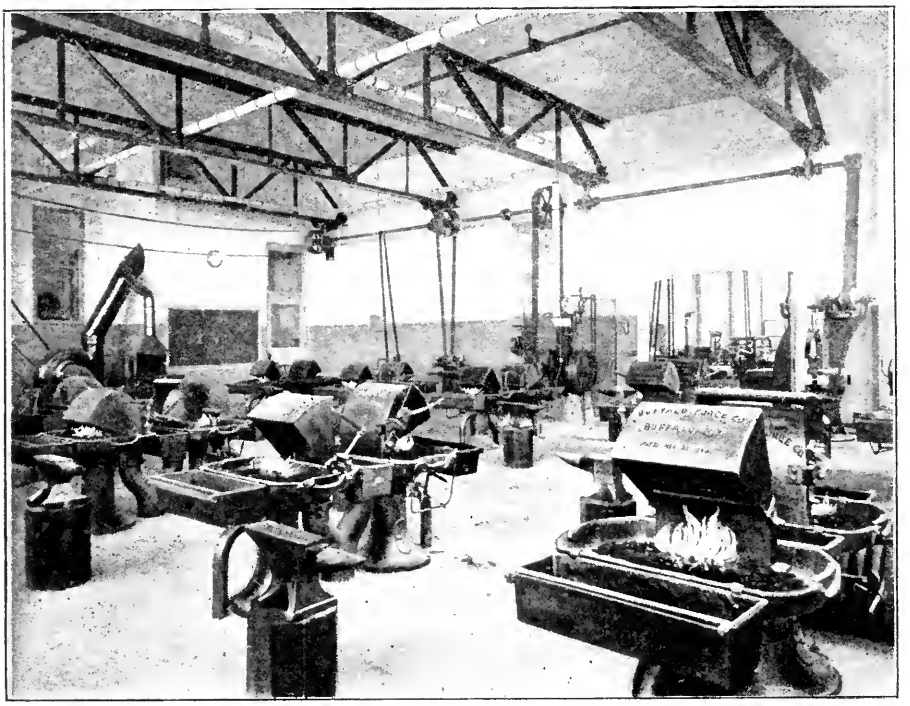


Fig. 43. Forge Shop Piping, All Underground, Stout M. T. School, Menomonie, Wis.

A practical equipment for twenty-four students is as follows:

24 forges, down draft	$960.00
24 anvils	216.00
6 blacksmith vises	27.00
24 tool stands	24.00
24 sets of tools (as follows): 1½-pound hammer, hot chisel, one each; ⅜-in. and ⅝-in. top and bottom swages ⅝-in. top and bottom fuller, poker, ¼-in. top and bottom	

fuller for each eight students, pair of pick-up tongs, pair each 1/4-in., 3/8-in., 1/2-in., 5/8-in. and 3/4-in., tool tongs, fire shovel, rake, 12-in. steel square, pair of 6-in. calipers, pair of 6-in. dividers for each six students, centre punch, 1/4-in. and 3/8-in. punch, 3/8-in. and 5/8-in. bolt-heading tool, set hammer for each three students, flatter for each three students, sledge for each four students, and cold chisel for each eight students, at $11.00 per set.....	264.00
Pressure and exhaust fans, with shafting, etc. (estimated)	300.00
Piping, etc. (estimated).....	150.00
Hand drill	20.00
Bench vise	5.00
Swage block	5.00
Bar shear	25.00
Total cost for equipment.....	$1,996.00

The following estimate for a forge equipment for twenty-four students is given by a manufacturer:

The forge shop to include 24 down draft forges (especially adapted for Manual Training School work), same being supplied with the necesssary blast and exhaust connections;

One blower of proper size to supply blast;

One steel plate exhauster to exhaust the smoke from the forges;

The necessary black steel blast and exhaust piping;

The underground tile ducts;

The freight, cartage, belting, counter-shaft and erection of all the above apparatus.

The approximate price for all the above would be about $1,950.00. Note that anvils, vises, tongs, and other necessary tools required for blacksmith work, are not included.

The following description of the forge shop of the Mechanic Arts High School, of Boston, and its equipment will be found of help to those considering a similar equipment.

"The forge-shop is a one-story brick structure, 93 ft. long and 41 ft. wide, which occupies the entire space between the two wings at the rear of the main building. It is lighted both by windows in the wall and by a large

monitor with sky-light. Its relation to the main building is such that the noise incident to the work causes no disturbance in the class rooms. It is equipped with B. F. Sturtevant Company's new down draft forges, and all necessary appliances for the instruction of three classes daily, each containing thirty-six pupils. The equipment of each forge is as follows:

A set of blacksmith's tongs (groove in jaw) for holding iron 1/8, 1/4, 3/8, 1/2, 5/8 inches; tool tongs for 3/4-in. square iron; square groove tongs for iron, 1/2-in. by 7/8-in.; bolt tongs, 1/2-in.; a poker for forge, 2-ft.; a dipper, 3 1/2-in. diameter, 3 1/2-in. deep, handle 15-in.; a rake for forge, 2-ft.; a coal hod; a forge shovel.

Upon a post conveniently located with reference to each of these forges is an Eagle anvil weighing 130 lbs., near which is placed a tool bench supplied with the following tools:

A cross peen hand hammer, 2 1/4 lbs.; a top and bottom swage, 1/2-in.; a hot chisel from 1 1/8-in. steel; a flatter, 2-in. face; a set hammer, 1 1/8-in. face; a hardy, 3/4-in. shank; a heading tool, 9-16-in.; a center punch, 1/2 in. by 5 in.; top and bottom fullers, 5/8-in.; a steel square, 12-in., graduated to 1-16-in. outside, 1-32-in. inside; Bemis & Call outside wing calipers, 6-in.; punches, one each, 1/4-in. 3/8-in.; copper plate, 2 1/2 in. by 2 1/2 in. by 5/8-in.; a dust brush.

"Each of these tool benches, 14 by 21 in. in plan, and 27 in. high, contains three drawers, one of which is assigned to each boy for the storage of the models which he has completed, or on which he is engaged. Each of these individual drawers is furnished with a 1 1/2 lb. ball peen hand hammer. Fourteen blacksmith's vises and one combination pipe vise are attached to benches firmly secured to the brick floor in convenient locations. Stock cut in pieces of the length required for the various exercises is stored in compartments in these benches. Fans of ample size produce blast for the forges, and carry away the foul air and products of combustion.

"In one corner of the room is a raised platform on which thirty-six arm chairs are placed for the use of

pupils during the demonstration lessons. The instructor's forge, located in front of this platform, is supplied with a Root hand blower for use when the engine is not running. Near this platform are two cases, one designed for the storage of blue-prints and miscellaneous supplies, and the other for prepared stock. The upper portion of the stock case is provided with glass doors, and is adapted to receive a series of models, made by the instructor, designed to show both the finished product and the important steps to be considered in making the model. A 75-lb. Laird and Sweeney power hammer, a New Doty Manufacturing Company's No. 7A power shear, a Goddard No. 3 drill press, an automatic drop press (Mossberg & Granville Company's pattern) built by pupils in 1899-1900, an emery grinder, a bolt heading machine, and numerous miscellaneous tools complete the equipment."

Maintenance.

The cost of Cumberland coal, Norway iron, tool steel, and sheet iron, used in typical courses, appears from a number of returns to be in the neighborhood of $2.00 per pupil. To this must be added the usual allowance for depreciation of equipment.

The tool equipment should be kept up by the instructor and students at the sole cost of raw materials.

Machine Shop.

The most advanced work in manual training is that of the machine shop, often given in the last year of the high school course. The equipment is the most expensive used in the manual training school. Power, either electric or steam, must be provided. The course generally

consists of bench-work in chipping and filing, and of machine work. The equipment for each will be considered separately.

Equipment for Chipping and Filing.

Vise	$7.00
3-16-in. square file, 6-in.	.08
Flat bastard file, 12-in.	.17
Hand second-cut file, 12-in.	.22
Hand second-cut, 3-in.	.11
Smooth file, 7-in.	.10
Half-round bastard file, 10-in.	.15
Half-round second-cut file, 5-in.	.09
Pillar file, 6-in.	.09
Taper saw file, 6-in.	.06
1-lb. hammer	.45
File card	.08
4-in. spring dividers	.31
3-in. steel scale	.32
4-in. steel square	2.00
Center punch	.11
Scriber	.12
Cold chisel	.09
Cape chisel	.15
Round-nose chisel	.11
Pair of copper vise jaws	.75
Total for individual equipment	$ 12.56
Benches, with drawers, for 24 pupils (estimated)	186.00
24 individual equipments	301.44
Total equipment for bench work	$500.00

Equipment for Machine Work.

The equipment for machine shop work varies greatly in different schools. There is little question but that a very large amount of money has been unnecessarily expended for such equipments in manual training schools mainly from the fact that some traditional precedent has been followed and much larger and more expensive tools installed than are needed or indeed adapted to the natural possibilities of this work. The following tools represent

something like the fundamental necessities for such an equipment. The prices quoted are those prevailing at the present writing and are subject to fluctuation.

6 engine lathes, 10-in. swing, 4-ft. bed, friction countershaft, rise and fall rest, at $118.00	$708.00
3 6-in. Sweetland combination chucks (with reversible jaws), at $13.00	39.00
16-in. by 16-in. by 3-ft. planer, with Newell vise	533.00
12-in. drill press, with capacity to drill 1¼-in. hole, automatic feed	118.00
10-in. by 4-ft. speed lathe	45.00
Grindstone and trough, with turning device....$25.00 to	85.00
	$1,528.00

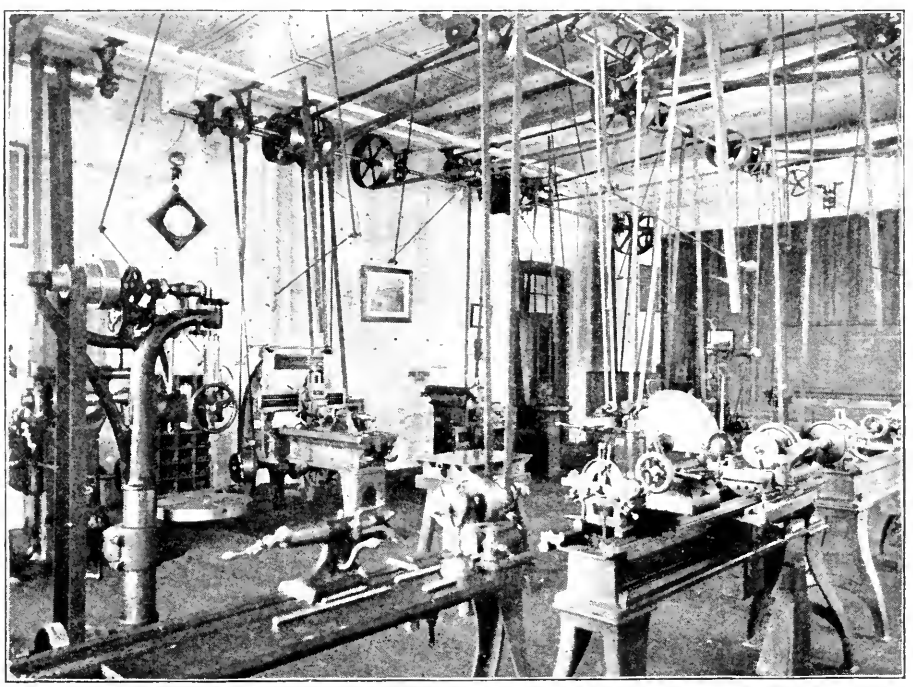


Fig. 44. Machine Shop, High School, Hartford, Ct.

Such an equipment would provide a separate tool for eight or even nine workers. It is possible to give the instruction upon these tools in conjunction with the less

expensive bench work by placing a portion of the class at the tools while the others are working at the bench, and rotating until all have had both tool and bench experience. Such an arrangement, however, gives but limited opportunity for the machine tool instruction and a larger number of such tools is desirable if the classes are of the usual size. The above set of tools, with the exception of the grind-stone, may be multiplied to the extent of providing individual tools for the class, or some of the following tools, which are arranged perhaps in the order of desirability, may be added.

14-in. engine lathe, 6-ft. bed, friction countershaft, taper attachment	$310.00
12-in. combination chuck, reversible jaws	22.00
No. 2 B. & S. universal milling machine	675.00
No. 1 sensitive drill press	70.00
No. 2 B. & S. tool grinder, with cutter grinding attachment	175.00
Shaper	270.00
	$1,522.00

Lathe Tools for Each Student.

Diamond point tool	$ .48
Round nose tool	.48
Side tool	.48
Parting tool	.48
Thread tool	.48
Centre punch	.11
Pair of 4-in. spring calipers	.31
Pair of 4-in. inside calipers	.27
6-in. steel scale	.60
Center gauge	.20
Lathe dog, ½, ¾, 1, and 1½	1.52
	$5.41

In addition to the above items, machine shop equipments comprise numerous small tools, almost too many to consider in detail, and varying in quantity and kind. The following is a quite complete working list for a class of 24:

Morse twist drills: 1 set Nos. 1 to 60; 1 set 1-16 in. to ½ in.; 1 each, 17-32 in., 9-16 in., 19-32 in., ⅝ in., 21-32 in. 11-16 in., 23-32 in., ¾ in., and 25-32 in.; 2 each, 1-16 in. 5-16 in., 23-64 in., and 13-32 in.; Nos. 1, 17, 20, 36 and 46; 6 each, 5-32 in. and ¼ in., Nos. 6, 16, 24, 25, 29, 31, 33 and 43; 12 each, ⅛ in., 3-16 in., and ⅜ in.; 24 of 3-32 in., and 12 3-32 in. center drills	$26.74
Reamers: Chucking, ¼ in. to 1 in. by 16ths.; centre, 2¼ in.; hand reamers, ¼ in. to 1 in. by 16ths.; Morse taper, Nos. 1 and 2; Morse taper roughing, 2 each of Nos. 1 and 2	$45.79
Mandrels, ¼ in. to 1 in	8.27
2 drill gauges	3.25
3 scratch gauges, 5 in., grad	2.25
Inside lock-joint, 6-in. calipers	1.05
Outside lock-joint 8-in. calipers	1.34
2 universal bevels, 3 in	2.56
Depth gauge, 4-in	.64
Double square, with bevel blade, 4 in	1.41
Level, 12 in	1.50
2 hack-saw frames, 8-in	1.54
3 surface gauges, 8-in	4.50
5 No. 19 micrometer calipers, with friction attachment, at $4.70	23.50
No. 30 micrometer caliper, with friction attachment	7.25
Vernier caliper, 6 inches, eng	12.75
12-in. bevelled steel straight edge	1.70
12-in. steel rule, No. 1, grad	1.07
12-in. steel rule, No. 4, grad	1.07
12-in. hardened steel try-square	8.50
4-in. key seat rule	2.13
Test indicator	12.75
Surface plate, 14 in. by 18 in	26.70
⅞-in. exterior and interior cyl. gauge	4.00
2 ball peen hammers, 12 ounces	1.08
2 ball peen hammers, 6 ounces	2.16
2 small riveting hammers	.60
Steel figures, 1-16 in., 3-32 in., and ⅛ in	1.80
Steel alphabet, 3-32 in	1.80
Soldering set	1.90
50-in. tape	2.85
6 knurl handles	1.50
1 dozen assorted knurls	5.40
Goodell breast drill, No. 6	2.60
Goodell hand drill No. 5	2.25
Coes' wrenches, one 6 in.; three 8 in. and 12 in	1.77
4 rawhide mallets, No. 2	1.88
Babbit hammer	1.25
2 steel screw clamps, No. 6	4.45

2 clamp dogs, No. 1, 6 of No. 2, and 2 of No. 3	8.18
Hand taps, 1 set ¼ in. to ¾ in	10.16
Machine screw taps, one 14x24, three each 3x48, 10x32, and 12x24, and two each 6x32, 8x32, 10x24, and 14x20	3.40
Machine screw dies, one each 3x48, 10x32, 12x24 and 14x36; and two each 4x36, 6x32, 8x32, 10x24, and 14x20	2.80
Round die set, No. 9B	9.00
Adj. round dies, No. 2, ¼ in. to ½ in	4.00
Nichols' tap wrenches, Nos. 00, 0, 1, and 2	4.75
Total for small tools	$276.84

Equipment for bench work	$500.00
Equipment of individual machine tools for class of 24	$4,000 to $5,000.00
Pulleys, belting, and shafting (estimated)	450.00
Equipment of lathe tools	129.84
Equipment of other tools	276.84
Total equipment for class of 24	$6,356.68

The following detailed statement* of the machine shop equipment of the Mechanic Arts High School, Boston, Mass., is of particular value in that it gives a very complete account of an existing equipment that has met the conditions imposed upon it by years of actual use. The equipment is quite elaborate, but the reader may eliminate from the list such of the equipment as his particular conditions may permit.

"This shop, like the forge shop, is equipped for classes of twenty-four pupils. The benches, 20 in. wide and from 32 to 36 in. high, which extend along three sides of this room, are divided into twenty-four sections, each provided with a vise and a tier of four drawers. One of the three lower drawers is assigned to each pupil, but the top drawer is reserved for the tools used in common by members of different classes. In his individual drawer

*Boston School Document, No. 4, 1901.

the boy stores the work upon which he is engaged, together with about a dozen files and a set of chisels and lathe tools. At the beginning of a lesson each pupil obtains from the tool-room a tray adapted to fit a compartment either in the upper drawer at his bench or on the tool-board of his lathe.

"This tray contains the following tools:

A Brown & Sharp hardened steel try-square, 3 in.; a Brown & Sharpe tempered steel rule, 6 in., No. 7 graduation; a Brown & Sharpe tempered centre gauge; Starrett outside lock-joint calipers, 6 in.; Starrett inside lock-joint calipers, 4 in.; Fay spring dividers, 3 in.; a file card; an Arkansas oil stone, 2 in. by 1 in. by 5-16 in.; a centre punch; a prick punch; a scratch awl; a centre chisel; a tin box for chalk; a key to the upper drawer at the bench.

"Upon the bench or in the upper drawer are kept:

A Spiers ball peen hammer, 1¼ lb.; a pair of brass vise jaws; hard wood blocks for use in chipping; a bench plate, 8 in. by 6 in. by 1 in.; a parallel 4 in. by 2 in. by 1 in.; a parallel 4 in. by 1½ in. by ¾ in.; a Draper steel oiler, No. 13; and a bench brush. The vises are of several varieties as follows: 13 Lewis, 4 in., No. 39; 1 Lewis, 4 in., No. 10, with swivel jaw and base; 7 Standard, 4 in., No. 91; 2 Mechanics, 4 in.; 1 Miller's Falls, 4 in.

"This shop is equipped with the following machine tools:

Three 14-in. engine lathes, 5-ft. beds, each having a compound rest and one a taper attachment, built by the Fitchburg Machine Works; one 14-in. engine lathe, 5-ft. bed, with compound rest, taper attachment, and wire chucks, built by the Hendey Machine Co.; one 14-in. engine lathe, 6-ft. bed, with compound rest, built by Prentice Bros.; sixteen 12-in. engine lathes, 5-ft. beds, with elevating rests, built by the F. E. Reed Co.; two 12-in. engine lathes, 5-ft. beds, with plain rests and taper attachments, built by F. E. Reed Co.; one 20-in. planer, built by Fitchburg Machine Works, supplied with a 10-in. Skinner vise with square base; one 17-in. planer built by Whitcomb Mf'g. Co., supplied with 8-in. Skinner vise with square base; one 14-in. illar shaper, built by the Pratt & Whitney Co.; one No. 2 universal milling-machine, built by the Brown & Sharpe Mf'g. Co., supplied with a Whiton milling-machine index chuck; one universal hand lathe, built by the Brown & Sharpe Mf'g. Co., supplied with shell chucks ⅛ in., 3-16 in.; ¼ in., 5-16 in., and ⅜ in.; a Whiton geared scroll chuck, 2½ in., and an Almond drill chuck, No. 2; four 10-in. hand lathes,

3 with 3½-ft. beds, 1 with 4-ft. bed, built by the Putnam Machine Co.; four 9-in. hand lathes 3½-ft. beds, one of which has a foot power attachment (F. E. Reed Co.'s pattern), built by pupils in 1897-8; one Walker universal tool and cutter grinder, complete with attachments, built by the Norton Emery Wheel Co.; one 20-in. standard upright drill, built by Prentice Brothers, fitted with Pratt drill chuck, No. 2 and Presto drill chuck with Morse taper collects; one upright drill, built by Sigourney Tool Co., fitted with Almond drill chuck, No. 2; one 10-in. sensitive drill, with centering attachment (Dwight Slate Machine Co.'s pattern), built by pupils in 1899-1900, fitted with Almond drill chuck, No. 2; two grindstone troughs, built by Brown & Sharpe Mf'g. Co., each fitted with a 39-in. stone and truing device; one Challenge wet and dry grinder, No. C, built by Appleton Mf'g. Co.; one Greenerd arbor press, No. 3; one Q & C shop saw, No. 2.

The following chucks are fitted to the engine lathes: 1 Westcott scroll combination, 10 in., three jaws; 2 Standard independent, 10 in., four jaws; 1 National independent, 9 in., four jaws; 2 Whiton independent, 7½ in., four jaws; 10 Skinner independent, 6 in., four jaws; 7 National independent, 6 in., four jaws; 1 National combination, 6 in., three jaws; 3 Union combination, 6 in., three jaws; 1 Whiton geared scroll combination, 6 in., three jaws; 1 Whiton extra heavy geared scroll, 5 in., three jaws; 1 Whiton geared scroll, 4 in., three jaws; 1 Pratt, No. 1; 1 Reid, No 1. The following chucks are fitted to the hand lathes: 1 Whiton geared scroll combination, 4 in.; 7 Whiton geared scroll, 3 in.; 1 Whiton geared drill; 1 Almond, No. 2; 1 Hartford, No. 1; 1 Little Giant, No. 0; 2 Reid, No. 0. Each engine lathe is furnished with a tool board of special design, adapted to receive the tool-tray, and to provide a convenient place for cutting and miscellaneous tools.

"Upon pegs in a vertical board fastened under the bed of each lathe are kept the face plates, change gears, back rest, chuck drill rest, and a set of dogs, ½, ¾ 1, 1½, and 2 in. There is no available space for an amphitheatre similar to those in the woodworking department. During the demonstration lessons pupils occupy tablet arm chairs grouped about the instructor's bench, which is placed in front of a large blackboard in the rear of the room. Near at hand is the tool-room, furnished with shelves and cases for the numerous tools required for the various kinds of work. One of these cases, which stands near the door, contains the small tools likely to be needed

frequently, and the tool-trays previously mentioned. An attendant delivers these trays to the pupils at the beginning of the lesson, and is always ready to furnish any desired tool in exchange for a pupil's check.

"The universal tool and cutter grinder and the power hack-saw are located in this room.

"The principal small tools are enumerated in the following list:

Morse twist drills: 1 set, Nos. 1 to 60; 1 set, 1-16 to ½ in.; 1 set A to Z; 1 each, 33-64, 17-32, 35-64, 9-16, 19-32, 39-64, ⅝, 21-32, 43-64, 11-16, 23-32, 47-64, ¾, 25-32, 51-64, 55-64, 59-64 in.; 2 each, 1-16, 5-16, 21-64, 23-64, 25-64, 13-32, 29-64 in.; Nos. 1, 17, 20, 36, 46; 6 each, 5-32, ¼, 17-64, in,; Nos. 6. 16, 24, 25, 29, 31, 33, 43; 12 each, ⅛, 3-16, ⅜ in.; 24 3-32 in.

Morse straight-way drills, 1-16, to ½ in.; Slocomb combination centre drills: 12 each, 1-16, 3-32, ⅛ in. Pratt & Whitney center reamers: 2¼ in., 6⅜ in. Drill gauges: 1 each, Nos. 1 to 60, 1-16 to ½ in., A to Z. Brown & Sharpe pocket screw and wire gauge. Wells Bros. centre drill chucks: 1 1-16, 8 3-32, 2⅛ in.

Carpenter hand taps, 1 set, ¼ to ¾ in. Machine screw taps: 1, 14 x 36; 3 each, 3 x 48, 10 x 32, 12 x 24; 12 each, 4 x 36, 6 x 32, 8 x 32, 10 x 24, 14 x 20. Machine screw dies: 1 each, 3 x 48, 10 x 32, 12 x 24, 14 x 36; 8 each, 4 x 36, 6 x 32, 8 x 32, 10 x 24, 14 x 20. Carpenter round die set, No. 9 B; Carpenter adjustable round dies, No. 2, ¼ to ½ in. Two Morse screw plates, A, with dies, ¼ to ½ in. Tap wrenches: Nichols Nos. 00, 0, 1, 2; Morse B; 6 Pratt & Whitney, J-6; 2 Wells Bros. No. 1. One Wells Bros. lathe die holder, DD. Carpenter pipe taps and dies, ⅛ to ¾ in. Barnes pipe cutter, No. 1.

Reamers: Pratt & Whitney hand, ¼ to 1 1-16 in.; Betts adjustable hand, ½ to ⅞ in.; Cleveland Twist Drill Co.'s fluted chucking, ¼ to 1 in.; Morse taper, Nos. 1, 2; Morse taper roughing, 2 each, Nos. 1, 2; Pratt & Whitney taper pin, Nos. 0 to 6. Mandrels: Pratt & Whitney, ¼ to 1 in.; Morse, 3 each 11-16, ¾, 13-16 in.

Starrett's tools: 3 scratch gauges, 5 in.; hermaphrodite calipers, 3 4-in., 1 6-in.; inside lock-joint calipers, 6 in.; outside lock-joint calipers, 8 in.; 6 universal bevels; depth gauges, 4 in.; combination set, 9 in.; patent double square with bevel blade, 4 in.; level, 12 in.; 4 hack-saw frames, Nos. 2, 8 in.; surface gauges, 2 No. 1, 1 No. 2; high speed indicator, No. 104; lathe test indicator No. 65.

Brown & Sharpe Mf'g. Co.'s tools: micrometer calipers with friction attachment, 9 No. 19, 1 No. 20, 2 No. 30; vernier cal-

iper, 6 in. Eng. and met.; 2 beveled steel straight edges, 12 in.; standard steel rules, 12 in., 1 No. 1 grad., 1 No. 4 grad.; hardened steel try-square, 6 in.; key seat rule, 4 in.; test indicator; mercury plumb bob, 3½ oz.; surface plates, 8—4½ x 6 ins., 1—6 x 12 in.; standard external and internal cylindrical gauges, ⅞ in.; 2 gas heaters; standard screw thread gauges, No. 285.

Pratt & Whitney caliper gages, ⅝ to ⅞ in.; 2 Speirs ball peen hammers, 12 oz., 4 6 oz.; 2 small riveting hammers; steel figures, 1-16, 3-32, ⅛ in.; steel alphabet, 2-32 in.; steel stamps, M. A. H. S., 1 each 1-16, 3-32, ⅛ in.; soldering set 40-ft. tape; 6 knurl handles with assorted knurls; Pratt & Whitney knurling tool; Goodell breast drill, No. 6; Miller's Falls hand drill, No. 5; pipe wrench, 18 in.; Coes wrenches, on each, 6 in., 12 in.; 4 rawhide mallets, No. 2; Babbit hammer, No. 2; 2 steel screw clamps, 6 in.; 2 Billings & Spencer steel C clamps, No. 3; 2 Decount heavy steel clamps, No. 2; 2 Besley parallel clamps, 4 in.; Almond turret head, No. 1; Pratt and Whitney hollow mills, 1 each, ¼ 5-16, ⅜ in.; Vanderbeek handy vises, 2—2⅛ in., 1—3¾ in., 1—6 in.; Billings & Spencer clamp dogs, 18 60. 1, 4 No. 2, 2 No. 3; Smith friction drill C, with socket wrenches; Walworth brass pipe wrench, ¼ in. to 1 in.

"The stock-room is furnished with shelves, compartments, and racks adapted to provide convenient storage for the many varieties of supplies, castings, and prepared metal stock that are needed by the classes. No pains have been spared to provide a convenient place for all of the numerous articles used in every department of the school, and it is an invariable rule that every article must be kept in its proper place. It is deemed as important to establish orderly habits as to teach mechanical principles."

The question of teacher's room, and locker and wash room (Fig. 18) is to be considered in connection with the machine shop. A cabinet, placed in the teacher's room, or in a separate stock room, should be provided for the storage of the numerous small tools and parts, and also for stock.

The installation of a good type of time-recording clock will serve the double purpose of keeping an accurate account of the student's class attendance, and also acquaint him with a phase of modern shop superintendence.

Maintenance.

The average cost per pupil for material, based upon returns from several typical schools, is $2.00 to $4.50.

To this must be added the proportionate part of a 10 per cent. equipment depreciation dependent on the number using the shop.

Sheet Metal Shop.

Sheet metal working is sometimes introduced in the first years of the high school course. In some of its forms it is well adapted to the seventh and eighth grades.

The work generally consists in the making of bowls, trays, vases, boxes, sconces, lamp-shades, and lanterns in sheet copper, brass or iron. Some embossing, chasing, engraving, and enameling is frequently added.

If a separate room is equipped for sheet metal work, it may be furnished with heavy benches similar to the chipping and filing benches of the machine shop (Fig. 45). A panel of tools for sheet metal work is shown in Fig. 46. The tool equipment for a class of twenty-four students is as follows:

24 parallel bench vises at $9.00	$216.00
12 pitch blocks (cast iron, about 20 lbs.) at $1.00	12.00
12 leather pads, to hold pitch blocks, at 75 cts	9.00
24 forming hammers at 75 cts	18.00
12 planishing hammers at 56 cts	6.72
6 chasing hammers at 80 cts	4.80
12 grooving tools at 13 cts	1.56
20 chasing tools, of varying sizes, at 25 cts	5.00
6 pairs of metal nippers at $1.22	7.32
6 hard wood mallets, at 60 cts	3.60
1 blow pipe and bellows, No. 9	5.25
1 blow pipe stand	5.00
1 12 gal. acid jar	.72
16 short vise anvils at 10 cts	1.60
16 long vise anvils at 15 cts	2.40
6 vise stakes at 40 cts	2.40
4 face plates, 4 x 4 x 1″ at 30 cts	1.20

6 pairs round nose pliers at 20 cts	1.20
6 pairs flat nose pliers at 20 cts	1.20
6 scrapers at 18 cts	1.08
2 scrapers at 10 cts	.20
6 6-in. flat files at 5 cts	.30
1 hand drill, with assorted drills	1.50
1 enameling furnace	27.00
Total cost of tool equipment	$335.05

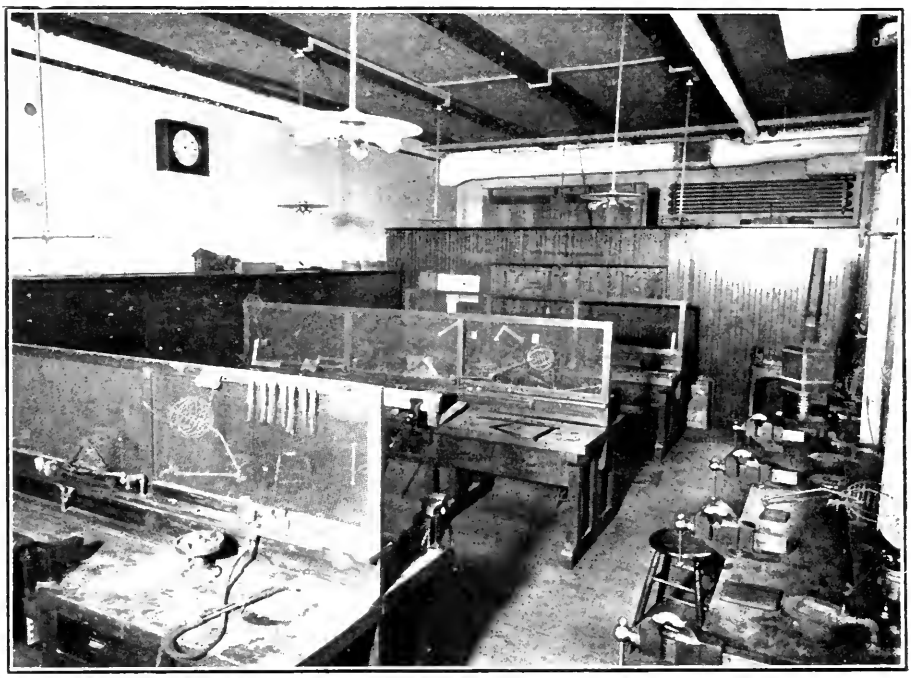


Fig. 45 Sheet Metal Working Room, Teachers College, New York.

With the above equipment annealing, embossing, chasing, engraving, and enameling can be done, as well as the beating-up of bowls, etc.

Mr. Frank G. Sanford* gives the following equipment for a class of twenty boys, with which he did successful work with seventh grade boys in the Oak Park, Ill., public schools:

*"Hammered Metal", The School Arts Book.

Economics of Manual Training.

Individual Equipment.

A bench, or at least a vise, is the first requisite; then a block of hard wood (oak, hickory, iron wood, 12″ x 3″ x 3″); a small block of steel or iron for riveting (very often these may be obtained from the scraps of some foundry at a very small cost. They should have at least one flat surface and one right angle and ought to be ½ inch or not more than ¾ inch thick); a block of soft wood, pine or cypress, free from knots, 9″ x 12″ x 2″; a pair of trimmer's shears, No. 6, cost 30 cts.; a small brad-set used as a rivet punch, 10 cts.; a half round file, medium, 15 cts.; a hard wood mallet, 25 cts. (this must be ground off on one end to present a rounded or hemi-spherical shape); a ball pein hammer,

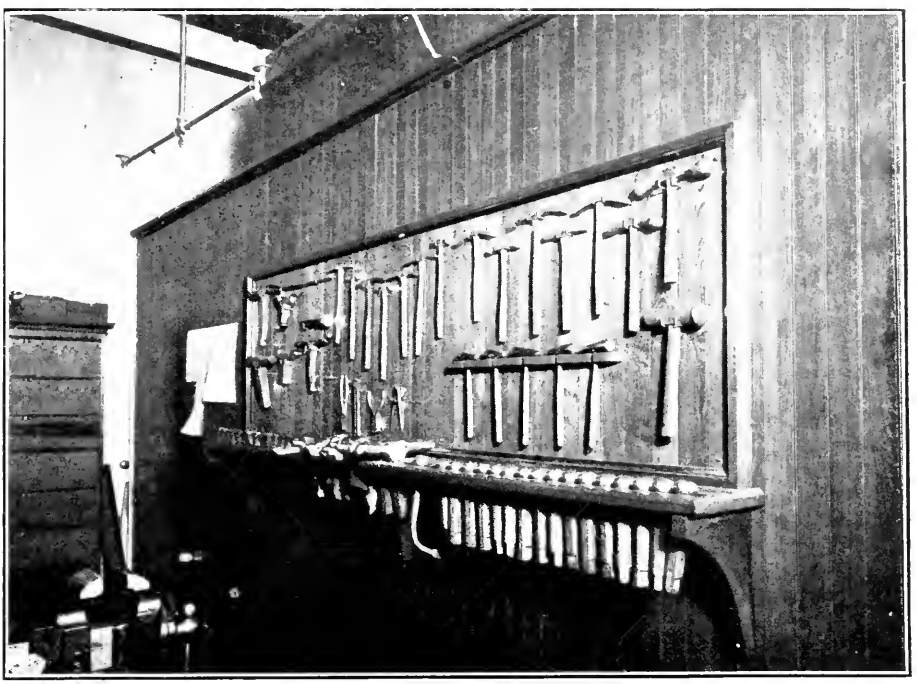


Fig. 46. Panel of Sheet Metal Working Tools.

40 cts.; a pair of flat pliers, 20 cts.; a pair of round nose pliers, 20 cts.; and a small screw driver, 15 cts.

General Equipment.

Four pair metal shears, large, cost of each, 50 cts.; 10 rat-tail files, 10 cts each; 5 wood rasps, medium, 15 cts. each; ¾ inch steel round head screws; wire brads, 20d, 10d, 6d; 12 sheets fine

emery paper; 5 small rivet sets, 20 cts. each; some scraps of soft wood; a roll of soft sheet brass, gauge 23, 12 inches wide, costing at wholesale 18 to 20 cts. per lb, or some sheets of soft sheet copper, gauge 23, costing 20 to 25 cts. per lb.

Maintenance.

The cost of maintenance depends upon the amount of sheet copper, sheet brass, and sheet iron used, varying greatly with the nature of the course. Screws, brads, rivets, enamel, and acid form a lesser expense item; $1.50 per pupil will cover the cost for high school work.

Mechanical Drawing Room.

An analysis of the problem of suitably equipping a room for mechanical drawing might resolve itself into a consideraion of the following factors:

General considerations.
Drafting tables.
Drafting instruments.
Models.
Storage for:—
    Boards.
    Instruments.
    Models.
Blackboard and furnishings.
Auxiliary rooms:—
    Teacher's room.
    Dark room.
Decorations.

General Considerations.

Mechanical drawing may begin in the seventh school year and may continue through the high school course. In the seventh and eighth years it may be made a part of the regular shop course. In the consideration of the bench equipment for wood-working (page 63) a drafting kit is given as part of the equipment to meet this condition.

The drafting-room, in common with all drawing rooms, should preferably have a northern exposure. The

light should be well diffused and abundant. If artificial light is found necessary, drop lights placed at the upper left-hand corner of each table may be provided. Probably the best method for lighting the drafting-room is with the inverted arc lamp. This method is in general use in the schools of Europe. The ceiling and walls of the room are whitened and the light from the lamp is reflected from them, the direct downward rays being cut off by a screen. The result is a soft, diffused light throughout the room, casting no shadows. One or two lamps will give abundant light for an ordinary sized drafting-room. This method of lighting may be used with advantage in class-rooms other than those devoted to drafting.

The general considerations regarding the distribution of benches, their relation to the source of light, aisle space, etc., discussed on pages 56–58, apply with equal force in the lay-out of the drafting tables.

Drafting Table.

Many school drafting-rooms are equipped with tables of special design, made to order. The building of especially designed tables was probably occasioned by the dearth of suitable tables on the market, other than the well-known adjustable type with central iron standard, and may also have been influenced by a desire to conform more nearly to common commercial practice. At the present, however, the building to order of tables of this type is unnecessary as many such have recently been placed upon the market to meet this demand.

These tables form one general class in present use and

the other class is composed of the adjustable type having a central iron standard (Fig. 47). There are many forms of the latter class upon the market, equipped with devices for raising and lowering, and for tilting the top at various angles. They take up a relatively small space. They range in price from $5 to about three times this sum. At

Fig. 47. Mechanical Drawing Room, showing adjustable tables, High School, Hartford, Ct.

the lower price the table is of the simplest construction, not even having a tool shelf. A tool shelf is a necessity. The cheapest desk having this addition retails at $6.00. Some of the more expensive desks of this type are so encumbered with clamps, set screws, and regulating devices, that their practicability is seriously impaired.

Tables of the former class are shown in Figs. 48-51.

The table shown in Fig. 49 cost $7.50 to build. Drawers for four sets of instruments are placed under the top, but no provision is made for storing the drafting boards within the table itself. In the desk shown in Fig. 48, two drawers are placed at one side of the table and storage

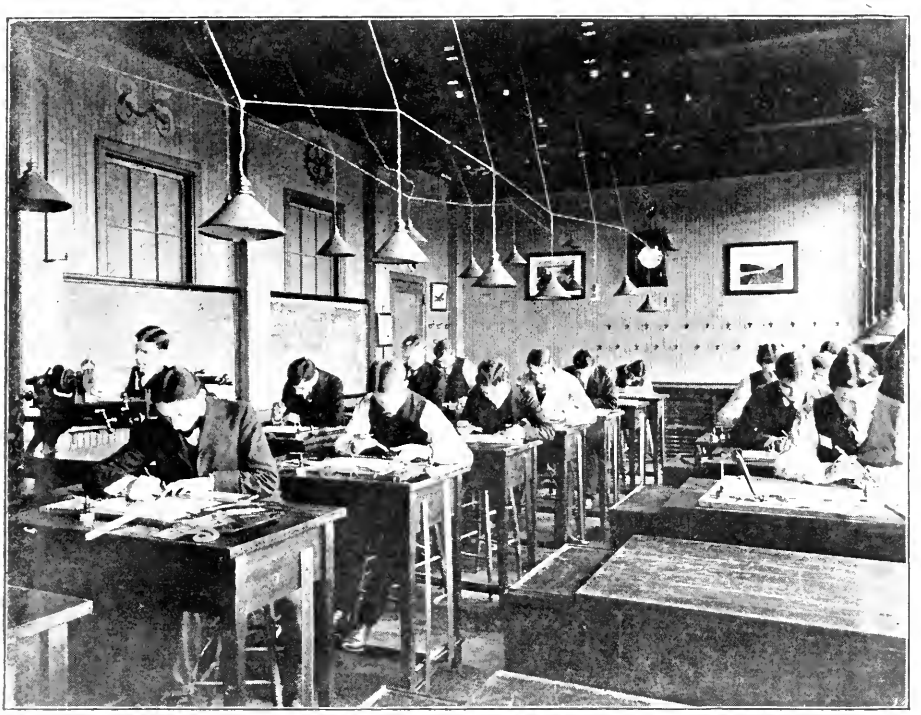


Fig. 48. Mechanical Drawing Room, showing table with drawers, Pratt Institute, Brooklyn, N. Y.

for one board is afforded directly beneath the top. Fig. 50 represents a practical table that is supplied on the market at $11.00 It has ample drawer space for two students and also accommodates two boards. Fig. 51 shows a type of self-contained drafting table affording

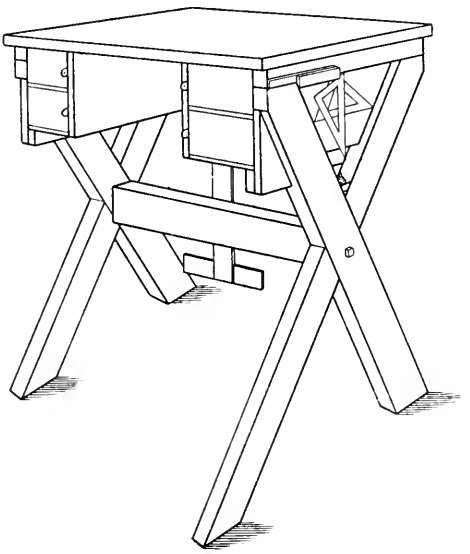


Fig. 49. Drafting Table Manual Training School, Springfield, Mass.

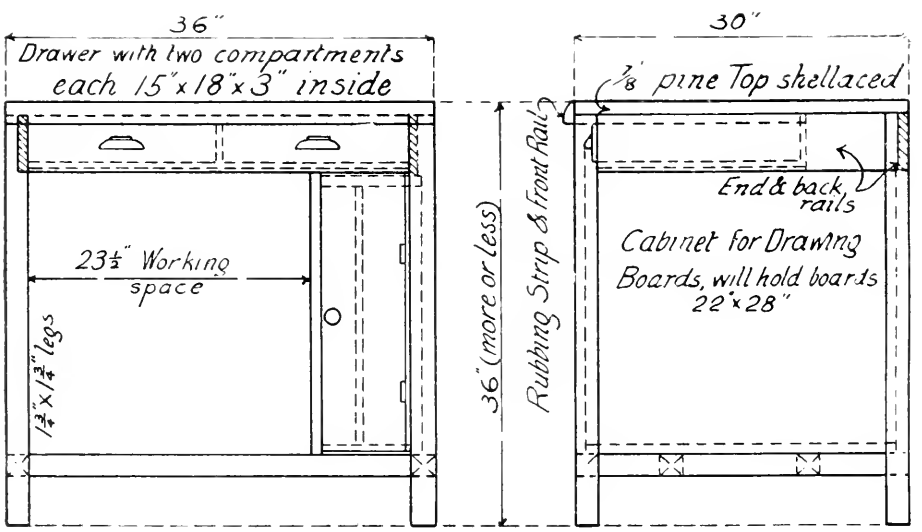


Fig. 50. Drafting Table.

accommodation for nine students and especially designed for high school work. It is so arranged that every pupil who occupies the table has an individual drawer in which to keep note-book, pencils, etc., and also an individual set of instruments, if provided. He also has a section in the closet for his drawing board. All tools, ink, etc., used in common are kept in the drawer over the closet. This plan makes it not only possible for a student to find the entire equipment at his table, but allows him plenty of working-room around the board. Each drawer and door is supplied with a Yale lock. The top is of white pine, 48″x24″, and the table is 41 in. high. The building of the table solid to the floor makes it easy to sweep around. This table lists at $30.00. A high stool may be provided for each table. Rubber tips, as shown in Fig. 47, will materially lessen the noise incident to moving the chairs about.

Instruments.

Each student should have the following equipment: drawing board, compasses, with needle point, pen, pencil, and lengthening bar, drawing pen, T square, two triangles, scroll, scale, thumb tacks, bottle of liquid India ink, pencil and ink eraser, and a hard and a soft pencil. A suitable outfit covering all the above items may be had for $5.00. The school may supply the entire outfit exclusive of ink and pencils, or it may supply only the board and T square, requiring the student to provide the remainder. Under public school conditions the latter plan is hardly permissible. Another arrangement sometimes resorted to is to provide the T square, two triangles, scroll, and scale for each table to be used in common by the different students occupying the table, and to provide sets of the remaining instruments for individual use. The

board should be about 16 x 20 inches. For advanced work, necessitating larger drawings, 22 x 28 inches. It should be of pine, about ¾-in. in thickness, and have cleats, either at the ends or beneath, to prevent warping. The triangles should be preferably of celluloid; a 9-in. 45° triangle and an 11-in. 30°-60° triangle. The T square

Fig. 51. Drafting Table.

should have a 24-in. blade. The scale may be a 12-in. flat, box-wood one, graduated to 1-16 in. the entire length of one edge and for quarter and eighth scales on the other edge. The triangular architect's scale is frequently used on account of the variety of scales it provides. Only the best ruling pen procurable should be provided; 4½ in. is a serviceable length. In choosing a compass and its acces-

sories all brass and highly polished instruments should not be considered. These are inferior tools. Select a medium-priced, German silver instrument, of dull finish, that shows plainly its honest construction. A 5½ in. compass of this kind, with its different parts, should cost about $2.00.

Models.

A plentiful supply of models should be provided. These may include type solids, models of constructive details in wood, pulleys, couplings and other shafting details, wrenches, bolts and nuts, valves, and parts of machines. One or two bench lathes or a small engine make admirable drawing models.

The wood-working shops, as well as the other shops, may be levied upon for contributions in this line.

Storage.

Boards.

The drafting boards may be stored in the tables, as shown above, or a separate cabinet may be provided. The construction of such a cabinet is simple. It may be of a height so that the upper board is within easy reach. Partitions placed at the widths of the boards should have cleats screwed to the sides as supports upon which to slide the boards. The cleats are placed far enough apart to permit free play for each board. Each stack of boards should be covered in front by a sliding door or a roller curtain.

Instruments.

The instruments may be stored in the tables, as shown above, or in separate drawers arranged in a cabinet. These drawers may be 6 in. wide by 12 in. long, and of a depth sufficient to allow for the ink bottle. They

should be provided with individual locks, and a master key for the teacher's use. The T squares may be stored on top of the drawing boards, or hung on the sides of the table.

Models.

The board and instrument cabinets may have cases, with shelving, placed above them for the storage of models.

Blackboards.

A slate board, lightly scratched over its entire surface with vertical and horizontal lines one inch apart, will be found of service for making demonstration drawings. Extra large wooden triangles, a three-foot wooden sraight edge, and a pair of blackboard compasses may be hung beneath the board. If room permits, demonstration seats may be placed before the blackboard, as described above for the wood-working shop.

Auxiliary Rooms.

Teacher's Room.

A room 8 x 10 may be reserved for the teacher's use. Besides a desk, chairs and book-case, it may have a case of drawers or a cabinet for the storage of paper, drawings and blue prints.

Dark Room.

A dark room, for the making of blue-prints and for other photographic uses, is a desirable adjunct to the drafting room. Provision should be made for the complete darkening of the room, and the walls and ceiling should be of a dull black. If blue printing alone is done, the darkening provision is not necessary. A sink is part of the equipment. If large blue prints are made, a large shallow wooden trough, for washing the prints, should be installed. Also a printing frame, on rollers, and a track

extending beyond the window should be provided. If the prints to be made are limited in size to about 18 x 24 in., ordinary printing frames will suffice.

All of these furnishings are supplied by many of the manufacturers of drafting instruments, and are fully described in their catalogues.

Decorations.

The walls of the drafting room may be hung with framed pictures of locomotives, large machine tools, and shop blue-prints of machinery. These later are especially suggestive to the students in showing actual commercial practice. Many manufacturers willingly furnish prints for this purpose. Blue-prints, from the U. S. Navy Department, of modern battleships, also form an acceptable decoration for a drafting room.

A small book-case supplied with standard books on drafting, and allied subjects, and with trade catalogues, is also a desirable addition.

The following estimate is for a $500.00 equipment:

24 drafting tables at $8.00	$212.00
24 drafting boards at 75 cts.	18.00
24 complete sets of instruments and tools at $5	120.00
Instrument and drawing board case	40.00
Case for storage of drawings, etc.	40.00
Blackboard furnishings	20.00
Various drawing models	50.00
Total cost of equipment	$500.00

Maintenance.

A good quality of drawing paper (preferably of a light buff color) costs one cent a sheet, 11 x 15 in. Allowing for waste, this brings the cost per pupil to between 50 cts. and 75 cts. An average from the reports received gives 63 cts. per pupil as the cost for maintenance.

Sewing Room.

Sewing in the earlier grades has been dealt with on

pages 34–37. The sewing in the upper grades may be conducted in a special room as shown in Fig. 52. The equipment may be a modification of the high school equipment to suit grade requirements.

The work of the high school usually consists in the drafting and making of garments.

I. Comprehensive equipment.

(1) Drafting and Dressmaking room for class of fifteen girls:

8 tables	60.00
Mirror	$15 to 20.00
Pedestal	6.50
Screen	8.00
1 gas stove, 3 burners	5.00
Connections to stove	2.00
8 irons—4 heavy and 4 long narrow	2.00
Wardrobe	$25 to 40.00
15 chairs	30.00
15 high stools	7.50
Clothes tree	3.50
5 sewing machines	$150 to 275.00
4 ironing boards	4.00
Board for curved seams	.90
15 boxes for materials	1.05
Paper roll holder	5.00
18 yard sticks	4.28
18 tape measures	.83
18 scissors	5.25
3 bust forms	1.50
2 skirt forms	6.00
	$338.31 to $483.31

(2) Sewing room—to accommodate 30 pupils:

Roll front case for materials for 90 pupils	50.00
Tables to accommodate 30 pupils	$30 to 80.00
30 chairs	60.00
30 footstools	60.00
36 boxes (6 large and 30 small)	4.20
Demonstration frame	2.00
	$206.20 to $256.20
Total cost of equipment I.	$544.51 to $749.51

II. Cheaper equipment for 15 in dressmaking and

30 in sewing. Dressmaking and sewing room combined:

8 tables, 5-foot kitchen..... $22.56

(An even less expensive table arrangement may be obtained of boards supported on sawhorses, when the two kinds of work are practiced in the same room. A convenient plan for the dressmaking tables is to have these hinged to the wall, so as to drop down when not in use.)

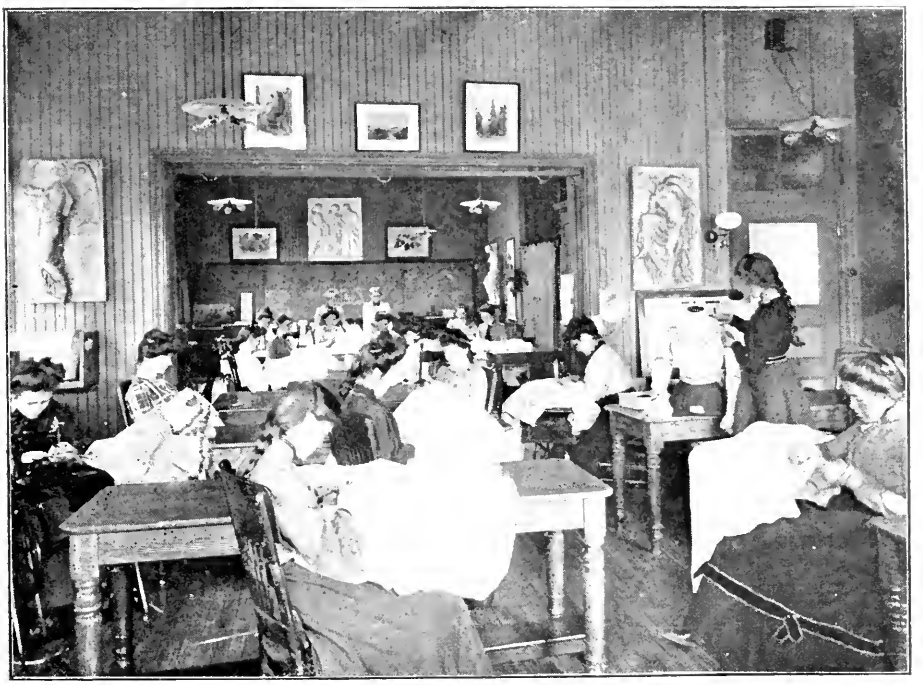


Fig. 52. Dressmaking Room, Pratt Institute High School, Brooklyn, N. Y.

30 chairs @ $7.50 per doz.		18.75
1 stove (3 burners) and tubing		3.75
6 irons		1.50
4 ironing boards		3.60
Wardrobe	$5.00 to	20.00
Mirror		12.00
4 sewing machines	$120 to	220.00
Screen		3.00
18 yard sticks		4.28
33 scissors (3 of them buttonhole)		9.40
6 large boxes @ .35		2.10

30 small boxes @ .07 ..... 2.10

Total cost of equipment II $323.04

Maintenance.

Average cost of maintenance for the work in the high school, if the pupils furnish their own garment materials, is about twelve cents per pupil.

Cooking Laboratory.

Cooking is very often taught in the seventh and eighth grades and in the high school. A specially equipped room is required.

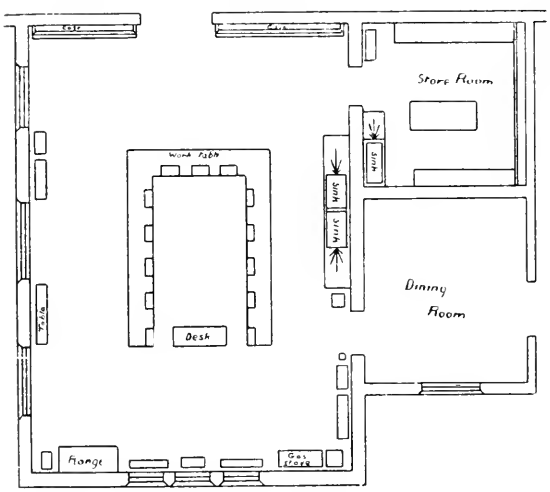


Fig. 53. Plan showing Horseshoe Arrangement of Cooking Tables.

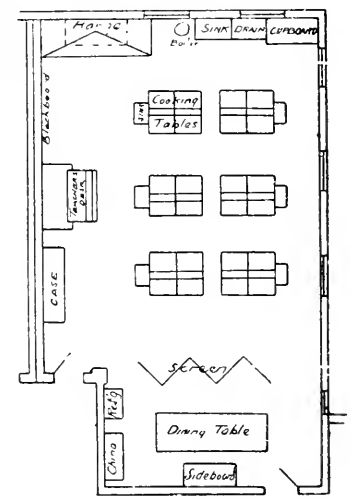


Fig. 54. Plan showing Group Arrangement of Cooking Tables.

In laying out a cooking equipment provision should be made for a kitchen equipment, a dining room equipment and a store room.

Kitchen Equipment.

The tables used for cooking should be from 30 in. to 33½ in. in height, according to height of pupils, and

should provide 25 in. to 33 in. width for each pupil, according to size. The tables may be arranged in the laboratory in the form of a continuous horseshoe, in parallel lines or as single tables. (Figs. 53 to 59, inclusive.) Shelves, drawers and cupboards are provided in the body of the tables for the storage of utensils and materials.

The materials used for covering the tops are various, including wood, plain and metal-covered, slate, marble, and tile. Of these, unglazed, vitrified white tile laid over asphalted paper and bound at the table edge by a metal strip is perhaps the best, although somewhat expensive.

Arrangements for individual cooking either in the form of single or double-burner gas stoves or stands with Bunson burners are provided where not prohibited on account of cost. When gas is not available, a reliable single-burner oil stove may be used for each pupil.

The specifications for the cooking tables of the New York City schools are as follows:

"The contractor shall furnish all material and labor required to make cooking tables, as shown on the detailed drawings and as hereinafter described, to be delivered and set in position at such times and at such locations or schools as may be specified by the Superintendent of School Supplies.

"For convenience in handling, each bench shall be built in nine separate sections or units, each unit containing two drawers and two closets. The ends and backs of units, also the doors to closets, shall be paneled, the framework mortised and tenoned together, and the panels tongued into grooves in the stiles and rails.

"The drawers shall be dovetailed in front, but the backs may be tongued and grooved together.

"The tops of benches shall be of narrow boards, well

joined, doweled and glued together, and secured to the top rail of units by wood or metal buttons, which shall permit the tops to go and come without breaking the glue joints.

"The doors shall be hung on 1¾ x 1¾ in. rolled brass butts, and be secured by bronzed iron cupboard catches and mortise tumbler locks, with 1¼ in. back set, each lock to have a key, and one key to pass all door locks.

"Drawers shall have bronzed iron pulls screwed on, and tumbler locks, each lock to have a key, and one key to pass all drawer locks. Every keyhole shall be finished with a suitable bronzed iron escutcheon screwed on.

"All exposed parts of benches shall be made of clear dry maple, of a uniform color and free from dark streaks or spots; the interior may be of any sound wood, preferably of maple, and all must be thoroughly dry.

"The tops of benches shall be treated with two coats of white shellac; the balance of exposed parts, also the edges and backs of doors, shall be treated with one coat of white shellac and one flowing coat of varnish, all sandpapered between coats.

"Contractor will be responsible for the material at the respective locations until accepted by the Superintendent of School Supplies."

The table shown in Fig. 59 is listed by a manufacturer of manual training benches at $22.00.

Table equipments for fifteen pupils, ranging in cost from $30 to $500 are as follows:

Table for fifteen pupils, with drawers for provisions and materials; cupboard, closed with roll-front, sliding board, and tiled top made of quartered oak, about	$500.00
Table for fifteen pupils, with one drawer for each pupil, made of Georgia pine, white pine or stained whitewood, from	$150 to 250.00
Kitchen tables may be used where funds are extremely limited, but are not advisable; about	30.00
Individual stove equipment for tables	$25.00 to 75.00
Coal or gas ranges	14.00 to 32.00

Economics of Manual Training.

Utensils.

The prices quoted are subject to a considerable discount in purchasing by the dozen.

Two for Each Pupil.

Bowl, 1 pint, earthen or granite	$ .06
Teaspoon, nickel or aluminum	.11
Towel, 1 yard long, crash	.16
	$ .33

One for Each Pupil.

Baking-dish, 1 quart, earthen or granite	$ .08
Bowl, 4-quart, earthen or granite	.20
Bread-board, small, wood	.20
Dish-cloth or mop	.10
Egg-beater, medium, wire or iron	.10
Frying-pan, small, iron	.15
Kitchen-fork, steel, wood handle	.05
" knife, " " "	.05
Mat, 8 inches square, linoleum	.05
Pepper-shaker, glass	.10
Plate, granite or tin	.15
Salt-shaker, glass	.10
Salt-spoon, bone	.05
Saucepan, with cover, 1 pint, granite	.18
Tablespoon, nickel or aluminum	.14
Vegetable brush, small, wood back	.05
Vegetable knife, steel, wood handle	.10
Measuring-cup, ½ pint, block tin	.10
	$1.95

One for Each Two Pupils.

Biscuit-cutter, block tin	$ .06
Bread-pan, medium, block tin	.17
Collander, medium, block tin	.17
Double boiler, 1 or ½ pint, block tin or granite	.50
Flour dredger, block tin	.10
" sifter (revolving handle), block tin	.22
Grater, medium, block tin	.10
Nutmeg grater, block tin	.08
Potato-masher, wire, wood handle	.09
Rolling-pin, wood	.06
Scrubbing brush, large, wood	.10
Skimmer, small, block tin	.09
Strainer, medium, block tin	.12
Teapot, 1 pint, earthen (Japanese)	.25
Thermometer	.75
	$3.01

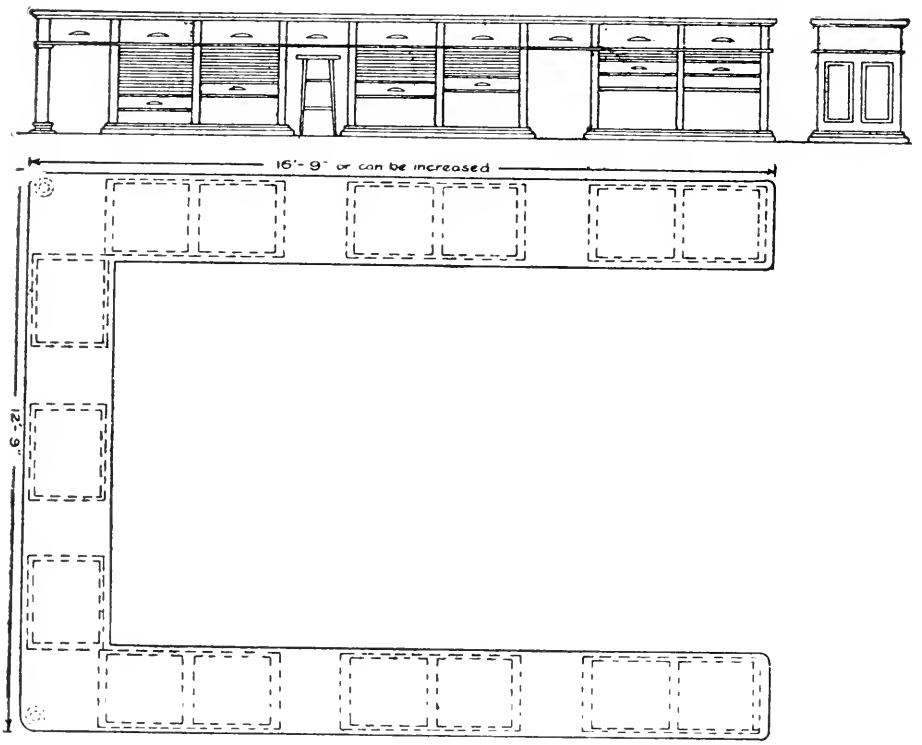


Fig. 55. Plan of Continuous Cooking Table, Teachers' College, New York.

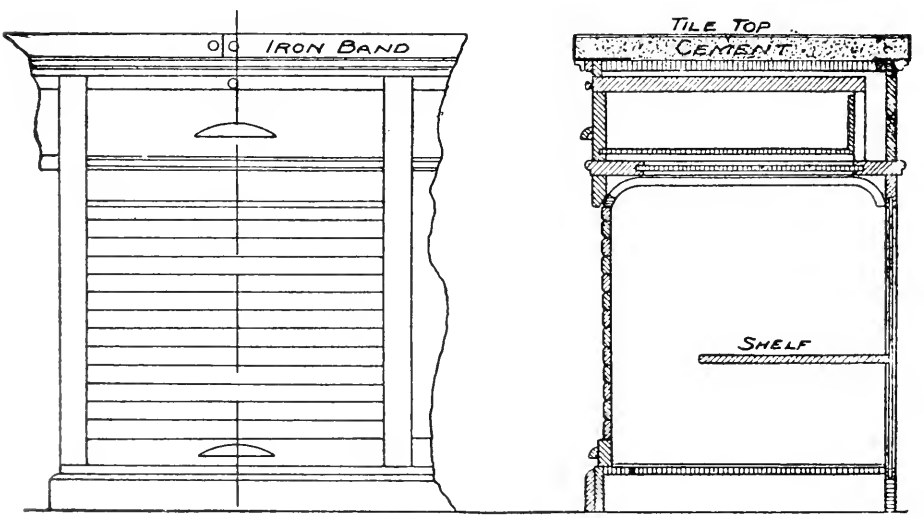


Fig. 56. Detail of Fig. 55.

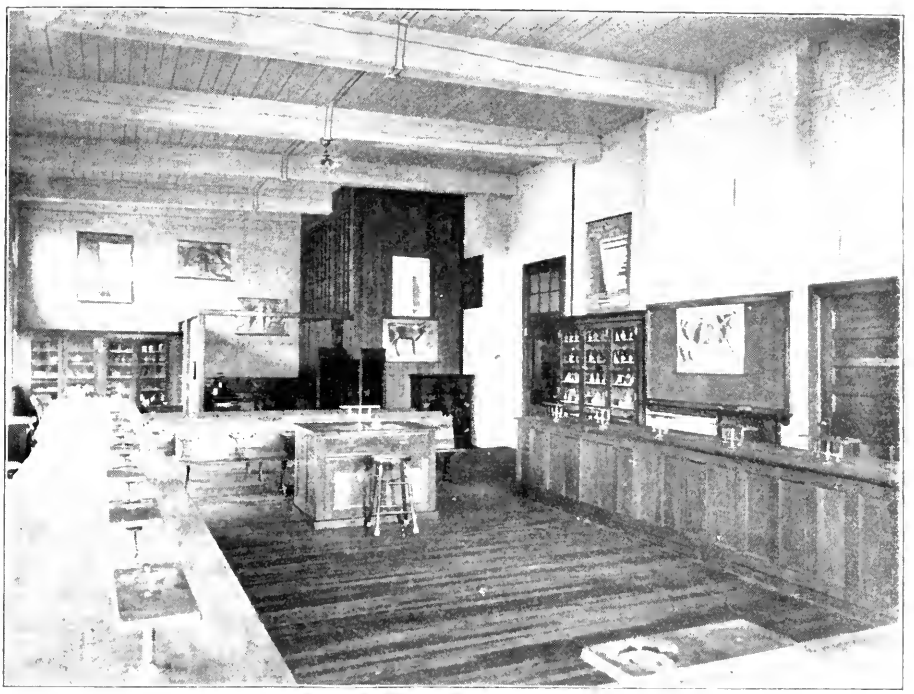


Fig. 57. Cooking Laboratory, Horseshoe Arrangement, High School, Hartford, Ct.

Fig. 58. Laboratory with Group Tables, Manual Training High School, Indianapolis, Ind.

Three or Four for a Class of Twelve.

Apple-corer, block tin	$ .05
Chopping-knife, steel	.50
" tray, wood	.40
Coffee-pot, 1 quart, granite or tin	.35
Japanned tray, medium	.45
Mixing spoon, large, wood	.05
Muffin pan, 12 in a pan, block tin	.15
Pitcher, 1, 2, and 3 quarts, earthen	.36
	$2.31

Two for a Class of Twelve.

Cake pan, medium, block tin	$ .25
Double boiler, 3 pints, granite	1.14
Griddle, medium, soapstone	1.12

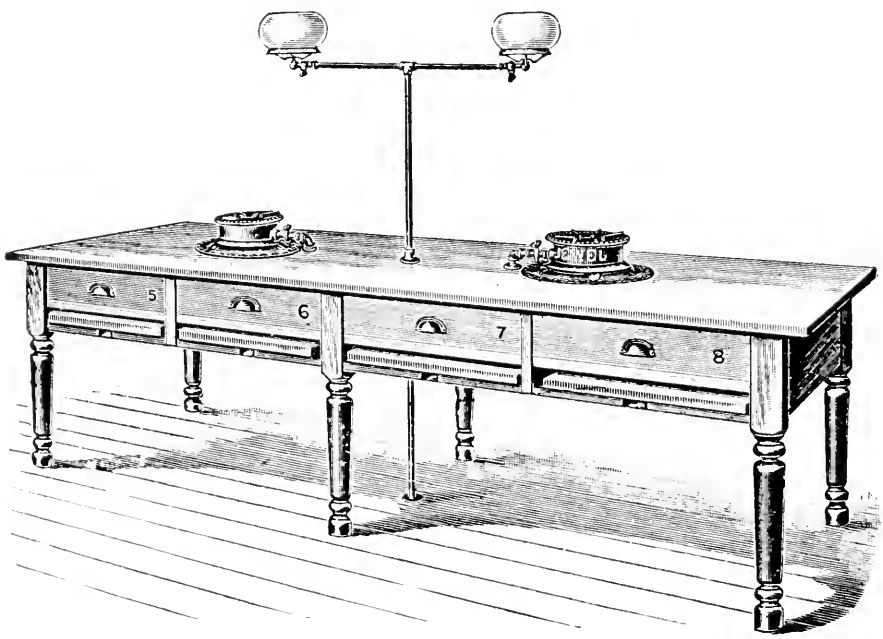


Fig. 59. Cooking Table.

Griddle cake turner, iron	.10
Kettle, 6 quarts, granite	1.86
Lemon squeezer, glass	1.05
Saucepan, 2 quarts, granite	.69
Strainer, 3 pints, block tin	.25
Toaster, wire	.10
	$6.56

One for a Class of Twelve.

Bread knife	$ .50
Can opener	.10
Coffee mill	1.12
Corkscrew	.10
Egg beater (Dover), large, iron	.10
Fruit jars, 1 dozen, 1 quart, glass	1.12
" " " 1 pint, "	.75
Frying-kettle, large, iron	1.82
Funnel, medium, block tin	.15
Ice-cream freezer (Packer's standard), 3 quarts	2.25
Jelly glasses, 1 dozen	.50
Knife sharpener	.55

Fig. 60. China Closet for Cooking Laboratory.

Larding needle	.20
Measure, 1 quart, block tin	.20
" 1 pint " "	.05
Meat broiler, medium, iron	.50
" knife	.20

Pot chain	.07
Pudding mold, 3 pints, block tin	.30
Scales, to 10 pounds	2.25
Skimmer, large, tin	.10
Steamer, medium, block tin	.55
Tea-kettle, large, iron, granite, or aluminum	.50
	$13.98

Utensils for Housework.

Blacking brush	$ .05
Broom	.25
Cheese-cloth duster	.10
Dust brush	.10
Dust pan	.15
Floor brush	.75
Lamp cloths	.10
Mop	.25
Pail, indurated fibre	.27
Scrubbing brush	.24
Whisk broom	.10
Window cloths, etc.	.10
	$2.46

Store Room Equipment.

Bread cloths	$ .10
6 crocks, large, earthen	2.40
6 " medium, "	2.00
4 flour pails, wood	2.00
Ice bag, 1 yard, duck	.15
1 dozen jelly glasses, with covers	.30
6 2-quart Mason jars, for coffee, etc., glass	1.20
Strainers, 5 yards, cheese-cloth	.25
" 1 yard, flannel	.20
Cupboards, for provisions, utensils, and dishes	$20.00 to 50.00
Refrigerator, medium size, to fit available space	$15.00 to 20.00
	$43.60 to $78.60

Dining Room Equipment.

Canton flannel cloth	
1 dining-table and 6 chairs	$20.00 to 32.00
2 tablecloths and napkins	10.00
Enough dishes for setting table and serving a simple meal	10.00

(It is advisable to buy dishes that come in "open stock," for if any are broken, they can be easily replaced. If setting of the table is not taught, a few dishes for the pupils will answer the purpose; say, for each, a cup, a saucer, and plate; and 4 vegetable dishes, 2 bread plates, and 2 platters.)

Knives, forks, spoons, glasses, etc.	20.00
	$60.00 to $72.00

(If a sideboard is added, the cost would be about $28.00 additional.)

The china closet shown in Fig. 60 is furnished by a dealer in manual training supplies for $60.00. The upper part has sliding glass doors and adjustable shelves. The lower part may have drawers.

Summary of cost of equipment to accommodate twelve pupils at a time:

Tables with cupboards, etc., stools, stoves, range, and sink	$550.00 to $650.00
Utensils (as per detailed statement)	85.87
Store room equipment	$43.60 to 78.60
Dining-room equipment	$60.00 to 72.00
Total cost of equipment	$739.47 to $886.47

On pages 96–98 is given the detailed equipment of the cooking laboratories at Evanston, Ill.

Maintenance.

The cost of maintenance for cooking, based upon individual work ranges from 2½ cts to 5 cts. per capita per lesson. From 3 to 3½ cts. is a fair average, and an allowance of 5 cts. per capita per lesson is liberal.

Laundry.

Few schools have a laundry equipment. The cost of equipping and maintaining a laundry in connection with school work is here given in order that the subject of this book may be covered as fully as possible.

The work may be given in the same room as that used by the class in cooking, or a separate room may be fitted up. In the latter case stationary tubs may be used in place of the portable ones. To these must also be added a laundry stove, water-heating arrangement, and suitable

plumbing. In the former case there should be a large closet provided for the storage of tubs, etc. About the walls of this closet there should be shelves for the work of the class. The following estimate is based on the plan of having the laundry work done under conditions involving a minimum expenditure of space and money:

Equipment for Class of Eight Pupils.

Large fibre tub	$ .83
Double boiler, for starch	1.03
Tea-kettle	.97
12 small fibre tubs	7.20
Small fibre pail	.20
Granite soap cooker	.65
Yellow earthenware bowl, 1 quart	.12
" " " 2 quarts	.16
" " " 4 "	.25
8 yellow earthenware bowls, 1 quart	.40
2 tin measuring cups	.20
6 tablespoons	.48
6 teaspoons	.30
Knife	.10
Wooden spoon	.05
100 feet of clothes line	.90
Clothes pins	.10
Towel roller	.10
Skirt board covers	
10 yards unbleached cotton cloth	.80
4 " cotton felting, 54 inches	2.00
1 yard white flannel	.40
Safety pins	.25
3 roller towels (7½ yards linen toweling)	.88
Dish pan, 14 quarts	.63
Universal wringer, large	4.25
2 universal wringers, small	5.00
Tin dipper	.20
Oval clothes basket	1.25
" boiler	1.25
6 4-foot benches	5.40
8 4½-foot skirt boards, with adjustable supports	12.00
8 small wash-boards, two-thirds usual size	3.00
2 clothes-horses (4 feet high, 4 folds)	1.76
Fringe brush	.63
3 soft brushes	1.14
3 whisk brooms, for sprinkling	.54

4 flat irons, 7 pounds	2.20
8 " " 5 "	2.56
8 " " 4 "	3.20
4 " " 3 "	1.40
(Cheaper irons may be had at 4 cents per pound.)	
8 Troy polishers	3.60
8 iron stands	.40
8 " holders (asbestos)	.32
Total cost of equipment	$69.10

Maintenance.

3 dozen boxes of soap	$ 1.50
Starch	.30
Bluing	.25
Beeswax	.40
Borax	.20
Ammonia	.20
White vine vinegar	.10
Salt	.05
Total cost of maintenance	$3.00

Cost per pupil, 37½ cents.

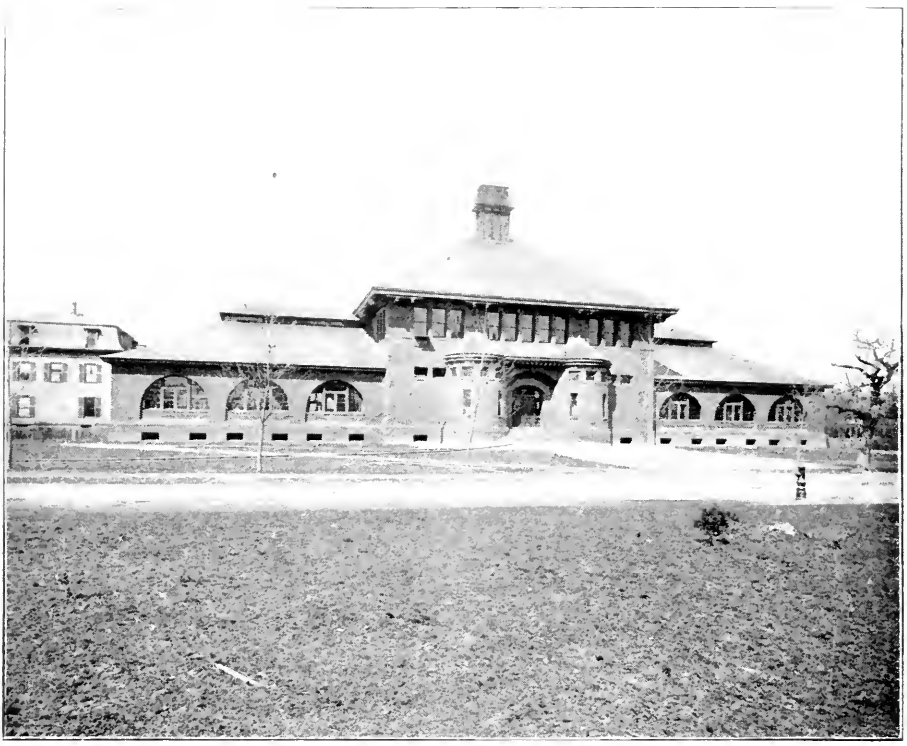


Fig. 61. Rindge Manual Training School, Cambridge, Mass.

The Manual Training Building.

▼ ▼ ▼

In order to supplement the foregoing detailed information regarding the equipping of the various shops, and also by way of suggestion for the general planning of the relation of a group of shops and other class rooms, a number of floor plans of manual training schools are here given. Aside from the building in which the makeshift plan is followed of having the shops occupy such space in

the general arrangement as is most expedient and convenient without special regard to isolation, there may be said to be two distinctive plans followed in designing a manual training building. The first calls for a separate building especially designed for shop purposes and containing no recitation rooms, either located within easily

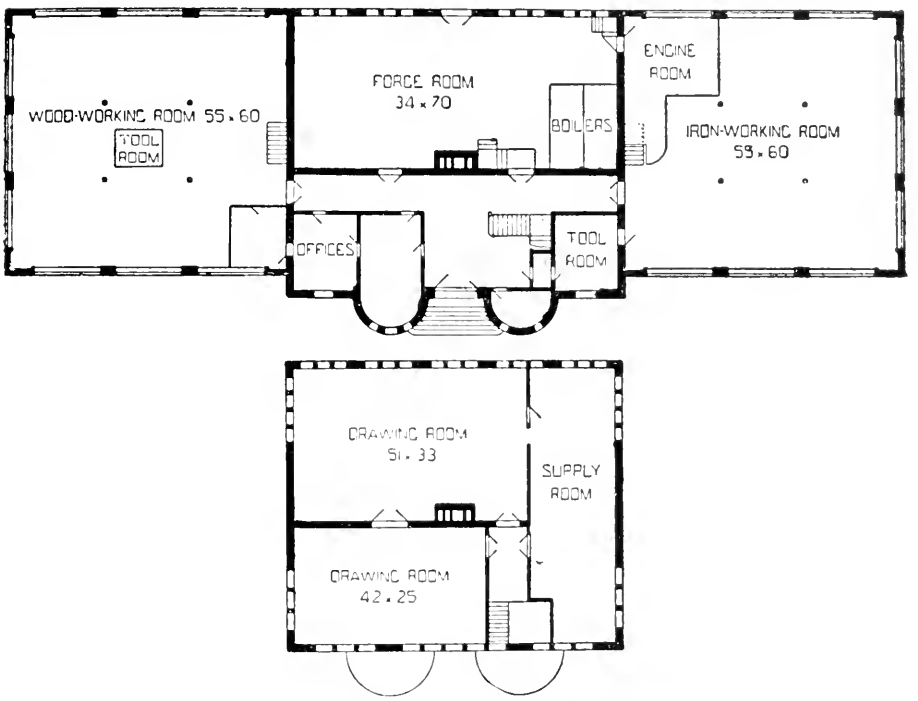


Fig. 62. Plan of Rindge Manual Training School, Cambridge, Mass.

accessible distance from the main building or connecting herewith, and the other calls for a building especially designed for a manual training school and containing recitation rooms as well as shops, the latter so designed (generally in wings) as to secure the greatest amount of light and at the same time to minimize the effects of noise.

Types of the former class are the Rindge Manual

Training School, Cambridge, Mass. (Figs. 61-62), and the Chicago Manual Training School (Figs. 66–69), and of the latter class the Mechanic Arts High School, Boston, Mass. (Fig. 65), and the Manual Training High School, Kansas City, Mo. (Figs. 63–64). The arrangement of manual training rooms in a Normal School is shown in Fig. 71.

If power is to be produced on the premises, the engine and boiler room may occupy a separate one-story building or may be installed in the basement, as shown in Figs. 63, 65 and 70. If electric power and light is also to be produced, the dynamos are installed in the engine room. Power may be had from motors driven by the street current. The most up-to-date equipment in the line of electric power installation may be found in the new Manual Training High School of the Borough of Brooklyn, where all overhead shafting is eliminated by having every machine driven by an individual motor. The rest of the equipment of this remarkable school is quite in keeping with the above item, as may be gathered from the following summary of the number of shops and laboratories:

"There are forty class rooms in the building, four shops for elementary wood work, one shop for wood turning and pattern-making, one for sheet metal work, a printing shop to accommodate thirty workmen, a machine shop, a blacksmith shop, a book bindery, four shops for plain garment work, rooms for the study of domestic science, including two kitchens, laundry, bedroom, dining room, pantry and infirmary. There are four mechanical draughting rooms, four free-hand drawing rooms, two zoölogy laboratories, two botanical laboratories, one physical laboratory, one chemical laboratory, one advanced

chemical laboratory for the study of assaying and metallurgy; one laboratory for the study of advanced physics, including steam and electrical engineering and an electric laboratory."

Attention is called to the one-story shop plan of the Chicago Manual Training School (Figs. 66–69). The one-story arrangement permits of the doing away with supporting pillars, eliminates the evils incident to the vibration caused by machinery, isolates the noise so as to minimize this annoyance to the recitation rooms, permits of easy trucking between shops, and affords a maximum of light and air. The method of lighting is the particularly unique feature of these shops. The method of factory lighting, so long popular in Europe, and known as the "saw-tooth" system, has been utilized. The sky-lights are made with the north slope steeper than the angle made by the sun's rays with the ground in the summer, and with the south slope opaque. The result is that the benches receive a maximum of diffused north light. Windows are also placed in the north wall to break what might otherwise be a somewhat cheerless aspect of four walls.

The disadvantage attaching to the use of one-story shops is believed to be confined to large cities where the high price of land would hardly justify so limited an edifice.

In the original edition of this book a list of books dealing with the methods and practice of manual training was incorporated. The need for including such a list has since been rendered questionable by the publication of the admirable and complete "Bibliography of Manual Training," by Mr. Arthur H. Chamberlain, wherein is tabulated not only the books on "Method and Practice," but also on the "Theory of Manual Training," as well as an

exhaustive list of magazine articles and also of American and foreign periodicals devoted to manual training. As a large part of the best manual training literature of the past few years has been in the form of contributions to periodicals, this "finding list" will be the more appreciated.

In writing this book, unique in its field, the attempt has been made to have it eminently practical and of real assistance to those to whom it is addressed. For obvious reasons it was impossible to give in the text the names of dealers, or to distinguish between the products of various manufacturers. On the other hand it was recognized that information as to where to purchase might be of much practical aid. It was therefore decided to admit a "Purchaser's Finding List," giving a somewhat complete list of representative dealers in the various materials used in equipping and maintaining manual training work. Such a list will be found in the succeeding pages.

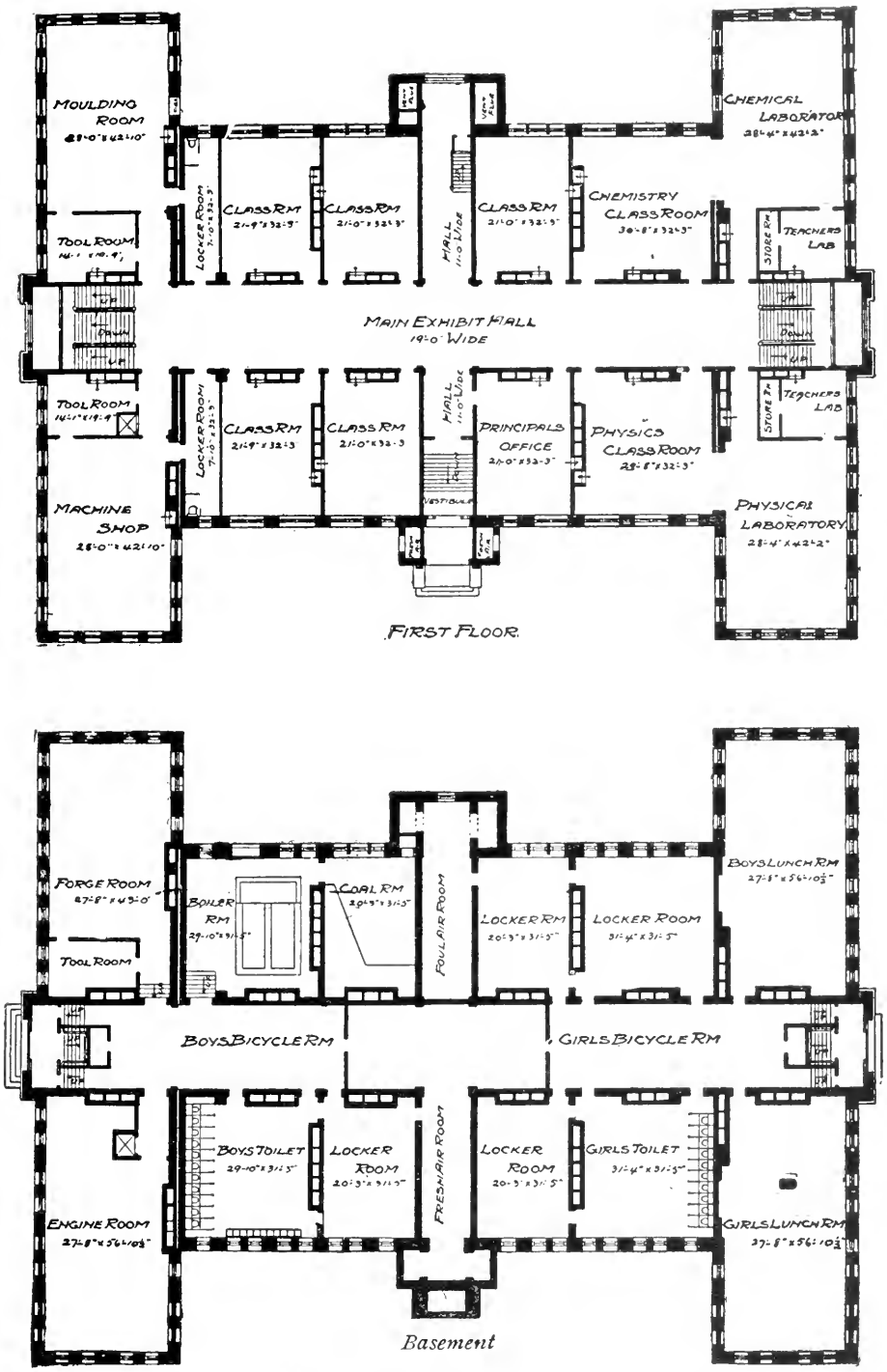
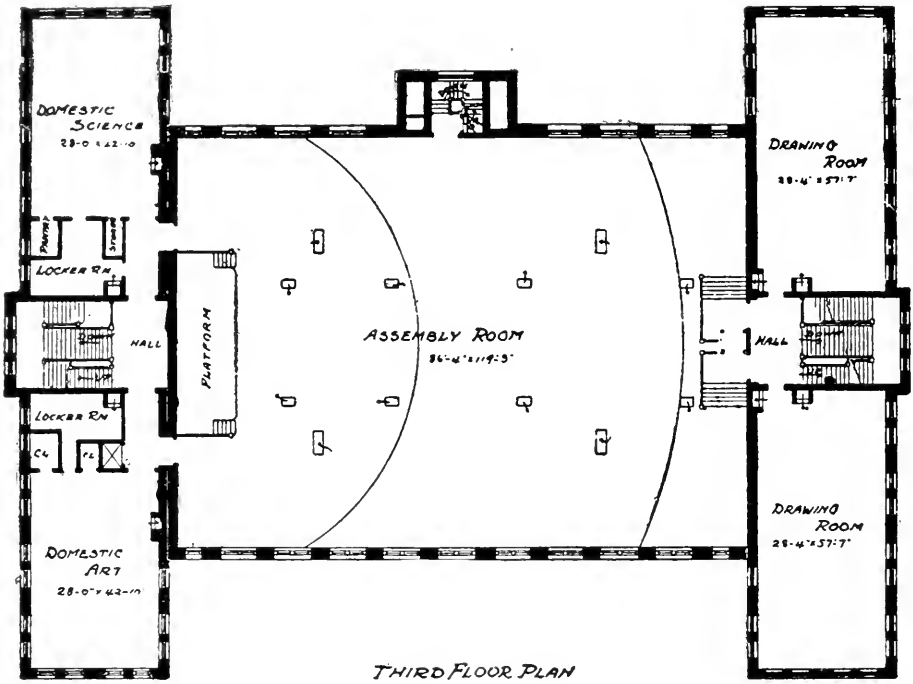


Fig. 63. Plan of Manual Training High School, Kansas City, Mo.



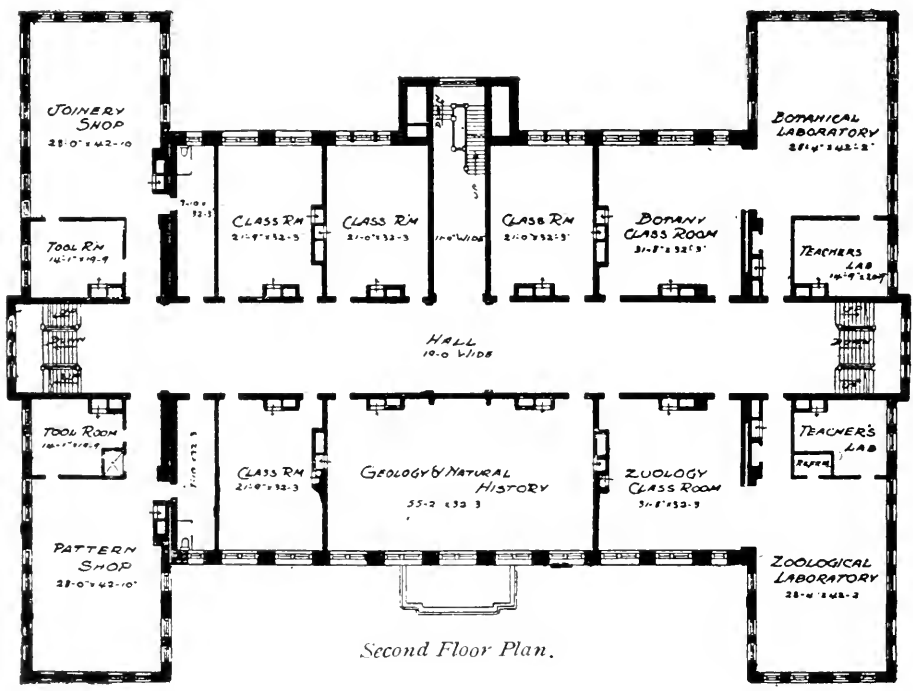


Fig. 64. Plan of Manual Training High School, Kansas City, Mo.

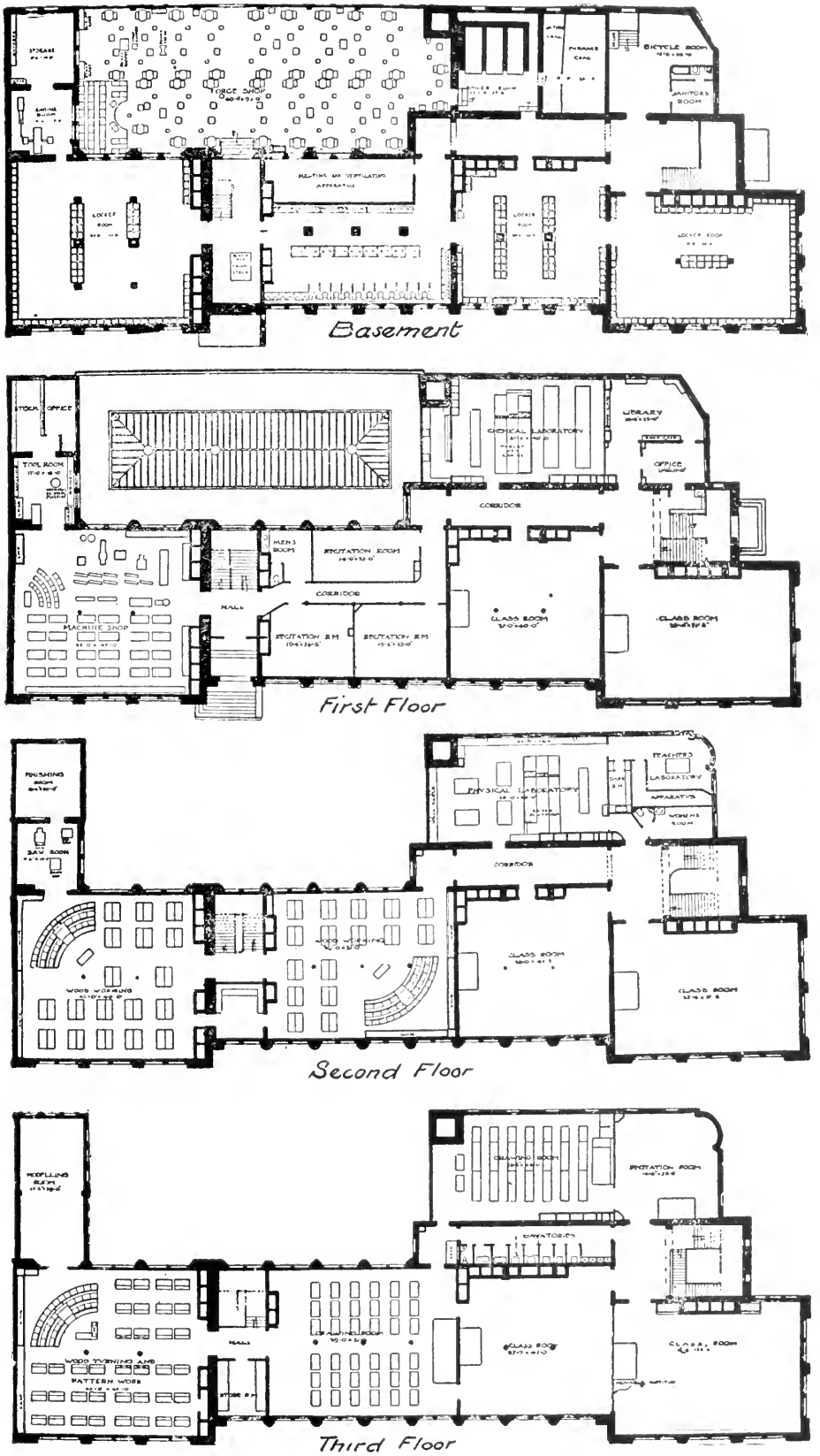


Fig. 65. Plan of Mechanic Arts High School, Boston, Mass.

Fig. 66. The New Building of the Chicago Manual Training School.

Fig. 67. Pattern Shop Chicago Manual Training School, showing Distribution of Light from Saw-Tooth Roof.

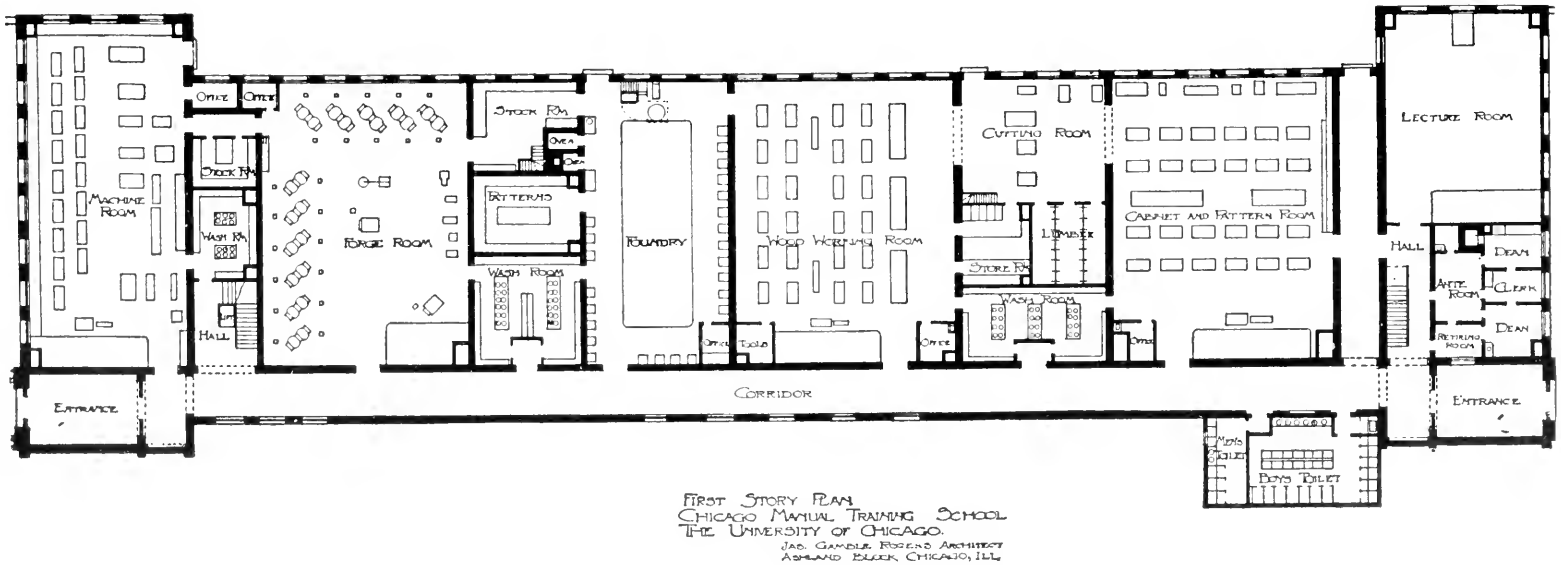


Fig. 68. First Story Plan Chicago Manual Training School.

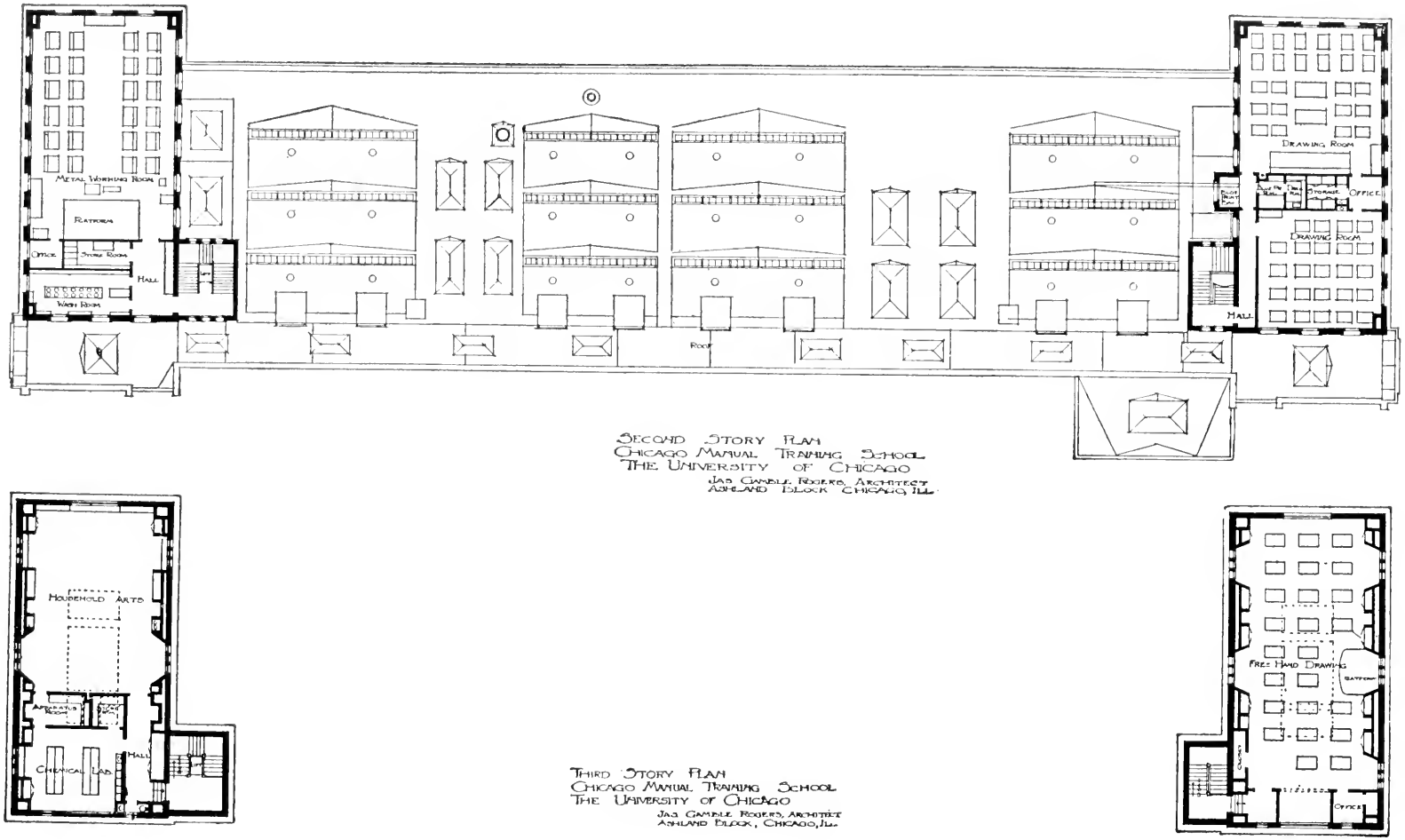


Fig. 69. Second and Third Story Plans Chicago Manual Training School.

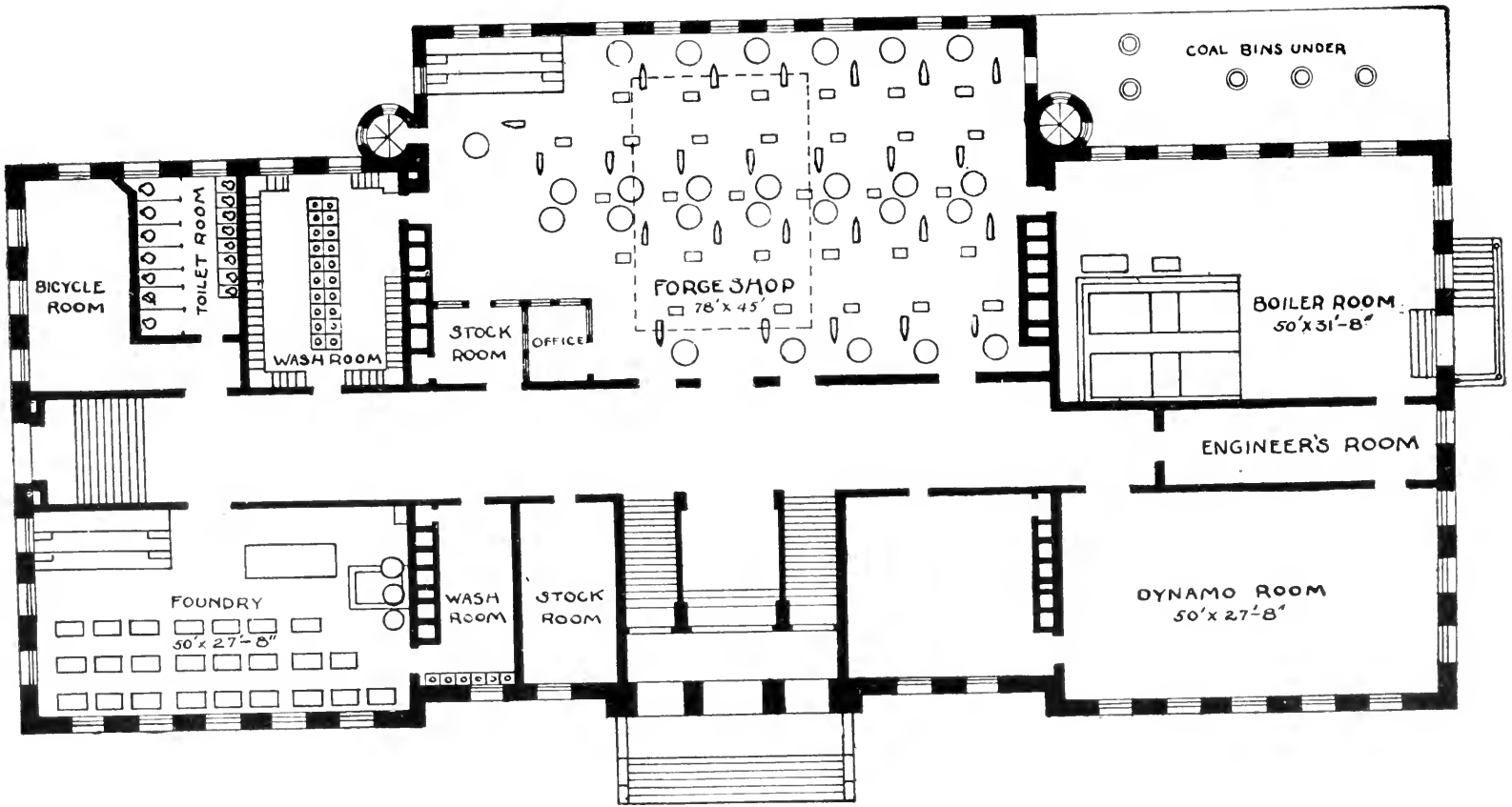


Fig. 70. Brookline Manual Training School, Basement Plan.

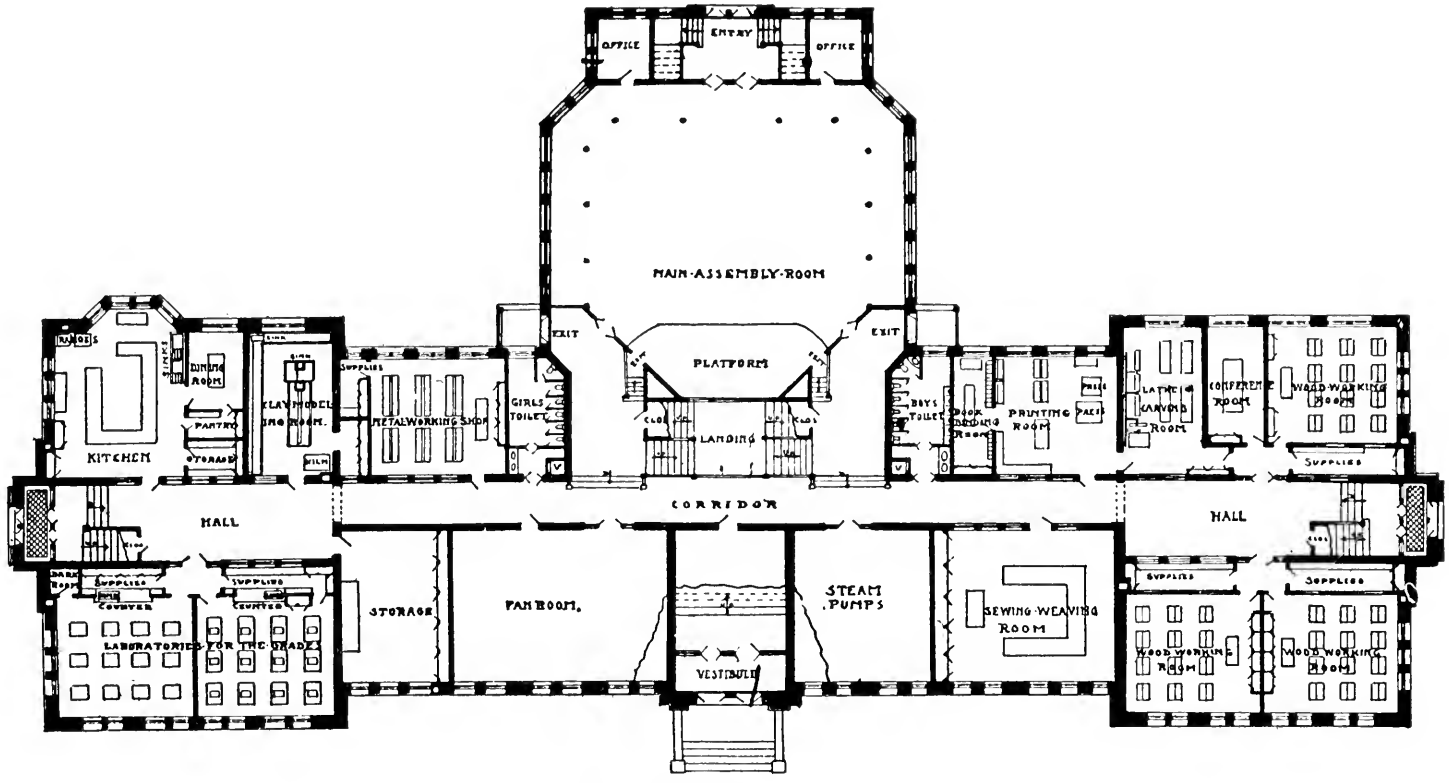


Fig. 71. Plan of the Rooms of the Department of Manual Training, Chicago Teachers College.

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Purchasers' Finding List

of makers of tools and supplies for Manual Training Work. Any of these people will be pleased to send catalogues and afford full information.

ABRASIVE MATERIALS.
Chicago Wheel & M'f'g Co., 47 W. Randolph St., Chicago, Ill.
Pike M'f'g Co. ..... Pike, N. H.

ANGLE BENDERS.
Estep & Dolan ..... Sandwich, Ill.

ANNEALING FURNACES—GAS.
American Gas Furnace Co. ..... New York.

ARBOR PRESSES.
Edwin E. Bartlett ..... Boston, Mass.

ARTISTS' AND DRAFTSMEN'S MATERIALS.
American Drafting Furniture Co. ..... Rochester, N. Y.
Chandler & Barber ..... Boston, Mass
Eugene Dietzgen Co. ..... Chicago-New York.
F. W. Devoe & C. T. Raynolds Co. ..... New York.
E. H. Fredericks ..... New York.
Hirshberg Art Co. ..... Baltimore, Md.
Keuffel & Esser Co. ..... New York.
Economy Drawing Table Co. ..... Toledo, O.
E. G. Ruehle & Co. ..... New York.
Semples' White Company ..... New York.
Henry M. Taws ..... Phila., Pa.
F. Weber & Co. ..... Phila., Pa.
Winsor & Newton, Ltd. ..... New York.

ASSAYING FURNACES—GAS.
American Gas Furnace Company ..... New York.

AUGERS AND AUGER BITS.
Chandler & Barber ..... Boston, Mass
Hammacher, Schlemmer & Co. ..... New York.
C. E. Jennings & Co. ..... New York.
Russell & Erwin Co. ..... New York.

AUGERS—HOLLOW.
Russell & Erwin Co. ..... New York.

BAKING POWDER.
Egg Baking Powder Co. ..... New York.

BAKERS' UTENSILS.
F. M. Bower Co. ..... New York.

BALANCES.
Wm. Ainsworth & Sons ..... Denver, Colo.

BAROMETERS.
Wm. Ainsworth & Sons ..... Denver, Colo.

BELLOWS.
Buffalo Dental M'f'g Co. ..... Buffalo, N. Y.

BELTING—LEATHER.
Champion Saw & Gas Engine Co. ..... Beaver Falls, Pa.

BELTING—RUBBER.
Champion Saw & Gas Engine Co. ..... Beaver Falls, Pa.

BENCHES—MANUAL TRAINING.
Hammacher, Schlemmer & Co.....New York.

BEVELS.
Braunsdorf-Mueller Co. .....Elizabeth, N. J.

BLACKBOARD—CLOTH—SILICATE.
N. Y. Silicate Book Slate Co.....New York.

BLACKBOARD—PAPER—SILICATE.
N. Y. Silicate Book Slate Co.....New York.

BLACKBOARDS—SILICATE.
N. Y. Silicate Book Slate Co.....New York.

BLOW PIPES.
American Gas Furnace Co.....New York.
Buffalo Dental M'f'g Co.....Buffalo, N. Y.

BLOWERS AND FANS.
American Gas Furnace Co.....New York.
Buffalo Dental M'f'g Co.....Buffalo, N. Y.
Buffalo Forge Co.....Buffalo, N. Y.
B. F. Sturtevant Co.....Hyde Park, Mass.

BLUE PRINTING APPARATUS.
American Drafting Furniture Co.....Rochester, N. Y.
Keuffel & Esser Co.....New York.

BLUE PRINT PAPER.
F. Weber & Co.....Phila., Pa.

BONBONS.
Huylers .....New York.

BOOKS—MECHANICAL.
The Derry-Collard Company.....New York.

BOOKBINDERS' ART GOODS.
Hoole Machine & Engraving Co.....Brooklyn, N. Y.

BOOK STAMPS AND TOOLS.
Hoole Machine & Engraving Co.....Brooklyn, N. Y.

BOOKBINDERS' MATERIALS.
Hoole Machine & Engraving Co.....Brooklyn, N. Y.

BOOKBINDERS' MACHINERY.
Hoole Machine & Engraving Co.....Brooklyn, N. Y.

BOOKS—TECHNICAL.
Wm. Ainsworth & Sons.....Denver, Colo
The Derry-Collard Company.....New York.

BORING BARS—LODGE & SHIPLEY.
Three Rivers Tool Co.....Three Rivers, Mich.

BRACES—BIT.
Hammacher, Schlemmer & Co.....New York.

BRISTOL BOARD.
Henry M. Taws.....Phila., Pa.

BRUSHES.
F. Weber & Co.....Phila., Pa.

BUFFING MACHINES.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.

BURLAP.
Hoffman-Corr M'f'g Co.....New York.

CABINETMAKERS' BENCHES.
A. L. Bemis.....Worcester, Mass.
Chandler & Barber.....Boston, Mass
Grand Rapids Hand Screw Co.....Grand Rapids, Mich.

CABINET HARDWARE.
Chandler & Barber.....Boston, Mass
Hammacher, Schlemmer & Co.....New York.

CALIPERS.
Wm. Johnson .....Newark, N. J.

CANDIES.
Huylers .....New York.

CARVERS' PUNCHES.
Braunsdorf-Mueller Co. .....Elizabeth, N. J.

CASE HARDENING FURNACES—GAS.
American Gas Furnace Co. ..... New York.
CHARCOAL.
Henry M. Taws ..... Phila., Pa.
CHARTS—EDUCATIONAL.
The Derry-Collard Company ..... New York.
CHINA PAINTING MATERIAL.
Fry Art Co. ..... New York.
CHISELS AND GOUGES.
Hammacher, Schlemmer & Co. ..... New York.
C. E. Jennings & Co. ..... New York.
Mack & Co. ..... Rochester, N. Y.
Russell & Erwin Co. ..... New York.
L. & I. J. White Co. ..... Buffalo, N. Y.
CHOCOLATE.
Huylers ..... New York.
CENTER DRILLS.
J. T. Slocomb Co. ..... Providence, R. I.
CLAMPS—WOOD.
Grand Rapids Hand Screw Co. ..... Grand Rapids, Mich.
Narragansett Machine Co. ..... Providence, R. I.
CLAY MODELLING TOOLS.
Hammacher, Schlemmer & Co. ..... New York.
CLAY (PLASTELINE).
Chavant M'f'g Co. ..... Jersey City, N. J.
COCOA.
Huylers ..... New York.
COLD CHISELS.
Braunsdorf-Mueller Co. ..... Elizabeth, N. J.
Wm. Johnson ..... Newark, N. J.
COMMUTATOR LUBRICANT.
L. B. Allen Co., Inc. ..... Chicago, Ill.
COMPASSES.
Wm. Ainsworth & Sons ..... Denver, Colo.
Eagle Pencil Co. ..... New York.
CONFECTIONERS TOOLS.
F. M. Bower Co. ..... New York.
COOKING TABLES.
A. L. Bemis ..... Worcester, Mass.
COPPER WORKING TOOLS.
Chandler & Barber ..... Boston, Mass
CORDAGE.
Hoffman-Corr M'f'g Co. ..... New York.
CORLISS ENGINE MODELS.
The Derry-Collard Company ..... New York.
COTTON WASTE.
Hoffman-Corr M'f'g Co. ..... New York.
COUNTERSINKS.
Wm. Johnson ..... Newark, N. J.
Wells Brothers Co. ..... Greenfield, Mass.
CRUCIBLE FURNACES.
American Gas Furnace Co. ..... New York.
CUTTERS—MILLING.
R. M. Clough ..... Tolland, Conn
DIES AND TAPS.
Bay State Tap & Die Co. ..... Mansfield, Mass.
Butterfield & Co. ..... Derby Line, Vt.
J. M. Carpenter Tap & Die Co. ..... Pawtucket, R. I.
Holroyd & Co. ..... Waterford, N. Y
Pratt & Whitney Co. ..... Hartford, Conn.
DIE STOCKS.
J. M. Carpenter Tap & Die Co. ..... Pawtucket, R. I.
Pratt & Whitney Co. ..... Hartford, Conn.
Wells Brothers Co. ..... Greenfield, Mass

DIVIDERS—WING.
Wm. Johnson ..... Newark, N. J.

DRAFTING MACHINES.
Universal Drafting Machine Co..... Cleveland, O.

DRAWING BOARDS AND TABLES.
American Drafting Furniture Co..... Rochester, N. Y.
A. L. Bemis..... Worcester, Mass.
Chandler & Barber..... Boston, Mass
F. W. Devoe & C. T. Raynolds Co..... New York.
Economy Drawing Table Co..... Toledo, O.
Keuffel & Esser Co..... New York.
Henry M. Taws..... Phila., Pa.
F. Weber & Co..... Phila., Pa.

DRAWING—BOOKS ON
The Derry-Collard Company..... New York.
Eugene Dietzgen Co..... Chicago-New York.

DRAWING INSTRUMENTS.
Chandler & Barber..... Boston, Mass
F. W. Devoe & C. T. Raynolds Co..... New York.
Eugene Dietzgen Co..... Chicago-New York.
Keuffel & Esser Co..... New York.
Patterson Tool Co..... Dayton, O.
E. G. Ruehle & Co..... New York.
Henry M. Taws..... Phila., Pa.
F. Weber & Co..... Phila., Pa.

DRAW-KNIVES.
C. E. Jennings & Co..... New York.
Russell & Erwin Co..... New York.
L. & I. J. White Co..... Buffalo, N. Y.

DRAWING PAPER.
Eugene Dietzgen Co..... Chicago-New York.
Henry M. Taws..... Phila., Pa.
F. Weber & Co..... Phila., Pa.

DRAWING PAPER—ISOMETRIC.
The Derry-Collard Company..... New York.

DRILLS—CHARD DEEP HOLE SPINDLE.
Three Rivers Tool Co..... Three Rivers, Mich.

DRILL GAUGES.
Pratt & Whitney Co..... Hartford, Conn.

DRILLS—HAND.
Hammacher, Schlemmer & Co..... New York.

DRILLS—MATTHEWS HIGH SPEED CORE.
Three Rivers Tool Co..... Three Rivers, Mich.

DRILLS—SENSITIVE.
Fox Machine Co..... Grand Rapids, Mich.

DRILLS—TWIST.
Standard Tool Co..... Cleveland, O.
Russell & Erwin Co..... New York.

DRILLS—UPRIGHT.
B. F. Barnes Co..... Rockford, Ill.
Sebastian Lathe Co..... Cincinnati, O.

EDGE TOOLS.
Mack & Co..... Rochester, N. Y.
L. & I. J. White Co..... Buffalo, N. Y.

EDUCATIONAL CHARTS.
The Derry-Collard Company..... New York.

ELECTRICITY—BOOKS ON
The Derry-Collard Company..... New York.

EMERY CLOTH AND PAPER.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.

EMERY OIL STONES.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.
Pike M'f'g Co..... Pike, N. H.

EMERY WHEEL DRESSERS.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.
Pike M'f'g Co.....Pike, N. H.

EMERY WHEELS.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.
Pike M'f'g Co.....Pike, N. H.

ENAMELING FURNACES—GAS.
American Gas Furnace Co.....New York.

ENGINES—GAS OIL AND GASOLINE.
Champion Saw & Gas Engine Co.....Beaver Falls, Pa.
Robertson M'f'g Co.....Buffalo, N. Y.

ENGINES—STEAM.
B. F. Sturtevant Co.....Hyde Park, Mass.

ENGRAVERS' TOOLS.
Hoole Machine & Engraving Co.....Brooklyn, N. Y.

EXPANDING MANDRELS.
Western Tool & M'f'g Co.....Springfield, O.

EXPANDING REAMERS.
Western Tool & M'f'g Co.....Springfield, O.

EXPANSIVE BITS.
Russell & Erwin Co.....New York.

EYE BENDERS.
Estep & Dolan.....Sandwich, Ill.

EYELETS AND TOOLS.
Eyelet Tool Co.....Boston, Mass.

FILES AND RASPS.
Champion Saw & Gas Engine Co.....Beaver Falls, Pa.
Hammacher, Schlemmer & Co.....New York.
Nicholson File Co.....Providence, R. I.
E. P. Reichhelm & Co.....New York.

FILES—SWISS PATTERN.
E. P. Reichhelm & Co.....New York.

FILES—AMERICAN SWISS.
E. P. Reichhelm & Co.....New York.

FILING CASES FOR DRAWINGS AND BLUE PRINTS.
American Drafting Furniture Co.....Rochester, N. Y.

FIRE EXTINGUISHERS.
Chandler & Barber.....Poston, Mass

FLUXES—(see Soldering fluxes).

FORGES.
Buffalo Forge Company.....Buffalo, N. Y.
B. F. Sturtevant Company.....Hyde Park, Mass.

FOUNDRY WORK—BOOKS ON
The Derry-Collard Company.....New York.

FURNACES—MELTING.
American Drafting Furniture Co.....Rochester, N. Y.
American Gas Furnace Co.....New York.
Buffalo Dental M'f'g Co.....Buffalo, N. Y.

FURNACES—TEMPERING AND ANNEALING.
American Gas Furnace Co.....New York.
Buffalo Dental M'f'g Co.....Buffalo, N. Y.

GAGES—LIMIT.
Pratt & Whitney Co.....Hartford, Conn.

GAGES—PIPE THREAD.
Pratt & Whitney Co.....Hartford, Conn.
Wells Brothers Co.....Greenfield, Mass.

GAGES—SCREW PITCH.
Wells Brothers Co.....Greenfield, Mass.

GAS BLAST FURNACES.
American Gas Furnace Co.....New York.

GAS GENERATORS.
American Gas Furnace Co.....New York.

GEAR CUTTING ATTACHMENTS FOR LATHES.
W. C. Young.....Worcester, Mass.

GLUE.
Wisdom & Co.....Chicago, Ill.

GLUE HEATERS.
Hammacher, Schlemmer & Co.....New York.
Oliver Machinery Co.....Grand Rapids, Mich.

GOUGES.
Russell & Erwin Co.....New York.

GRAPHITE AND PLUMBAGO.
Pettinos Brothers .....Bethlehem, Pa.

GRINDERS—CUTTER AND REAMER.
R. M. Clough.....Tolland, Conn.

GRINDERS—DRY.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.

GRINDERS—PLAIN.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.

GRINDERS—WATER TOOL.
B. F. Barnes Co.....Rockford, Ill.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.

GRINDSTONES.
Hammacher, Schlemmer & Co.....New York.

HAMMERS.
Hammacher, Schlemmer & Co.....New York.

HAMMERS—HAND.
The David Maydole Hammer Company.....Norwich, N. Y.

HAND SCREWS.
Chapin-Stephens Co. .....Pine Meadow, Conn.
Grand Rapids Hand Screw Co.....Grand Rapids, Mich.
Narragansett Machine Co.....Providence, R. I.

HATCHETS.
L. & I. J. White Co.....Buffalo, N. Y.

HEATING MACHINES—(Gas).
American Gas Furnace Co.....New York.

HEATING SYSTEMS.
Buffalo Forge Co.....Buffalo, N. Y.
B. F. Sturtevant Co.....Hyde Park, Mass.

ICE CREAM FREEZERS.
F. M. Bower Co.....New York.

ISOMETRIC PAPER.
The Derry-Collard Company.....New York.

INKS—WATERPROOF.
Eugene Dietzgen Co.....Chicago-New York.
Henry M. Taws.....Phila., Pa.
F. Weber & Co.....Phila., Pa.

JOINTERS.
Greaves, Klusman & Co.....Cincinnati, O.

KNIVES—SLOYD.
Hammacher, Schlemmer & Co.....New York.

KNURLS.
Braunsdorf-Mueller Co. .....Elizabeth, N. J.

LATHE DOGS.
Western Tool & M'f'g Co.....Springfield, O.

LATHE TOOLS.
Armstrong Bros. Tool Co.....Chicago, Ill.

LATHES—BUFFING.
Chicago Wheel & M'f'g Co..47 W. Randolph St., Chicago, Ill.
F. E. Reed Co.....Worcester, Mass.

LATHES—ENGINE.
B. F. Barnes Co.....Rockford, Ill.
Greaves, Klusman & Co.....Cincinnati, O.
Pratt & Whitney Co.....Hartford, Conn.
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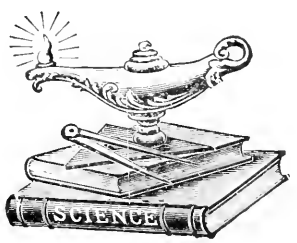

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